MECHANICAL ENGINEERING

April, 1958

Plastics Engineering 1956-1957 — A Review of Developments

For the Graduating Class — Professional Registration

Human-Factors Engineering — A Working Program!

Job-Shop Challenges Materials-Handling Systems

The Use of Nondestructive Testing on Steel Castings

Design Characteristics of Magnetic Steel Castings

Process Controls for Making Turbine Castings

A 225,000-Psi Commercial Cast Steel

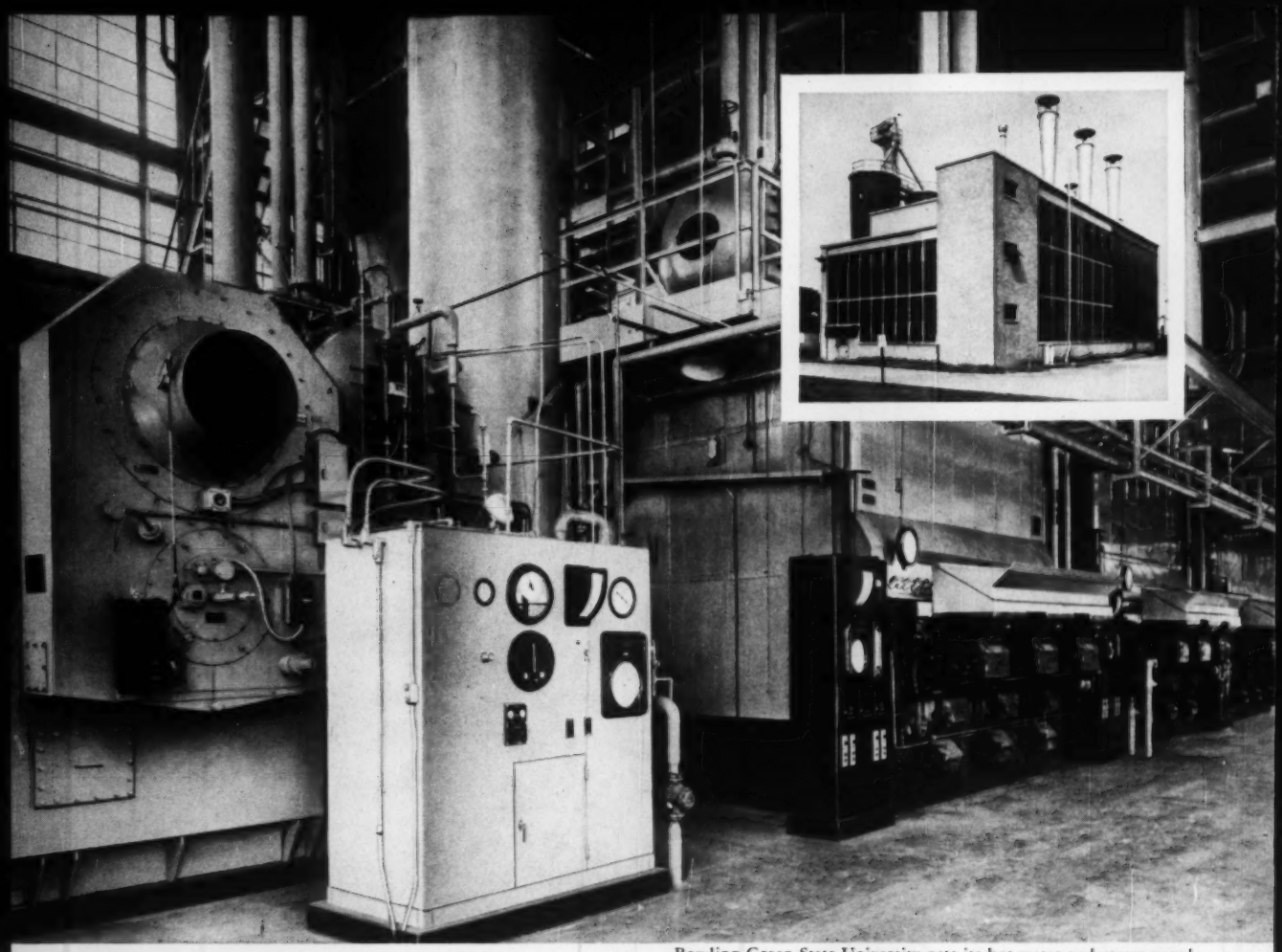
Gas Turbines in the Arabian Desert

The Spring Back of Coil Springs

Aviation's Golden Age

Complete Contents on Pages 3 and 5

Continuously Cast Copper Cakes



Bowling Green State University gets its hot water and steam supply from 4 B&W Integral Furnace Boilers in this modern power plant. Heating Contractor: John Paul Jones, Cary & Miller, Cleveland, Ohio.

B&W Boilers at Bowling Green University Operate on Low-Cost Coal, Cut Downtime

Reordering is a vote of confidence that occurs regularly for B&W. The Bowling Green State University steam plant is a case in point. In 1950-1951, B&W installed three stoker-fired, Integral Furnace Boilers to supply hot water for laundry, kitchens, hospital, bathrooms and the steam supply for entire campus. Their high performance has just led the University to specify and install a new natural-gas-burning Integral Furnace Boiler. Taking over during the reduced-session summer months, the new boiler is particularly adapatable for on-off loads, thus helping Bowling Green to stay within its efficient budget.

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Maximum capacity in small boiler room space is provided by B&W Integral Furnace Boilers as well as high fuel economy, and economical, fast steaming. Their quality has been proved in action in hundreds of installations, in industry and institutions throughout the nation.

Like all B&W installations, the ones at Bowling Green share the advantages made possible by B&W's national network of plants and engineers, which maintain the highest standards in design, manufacture, installation and service. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

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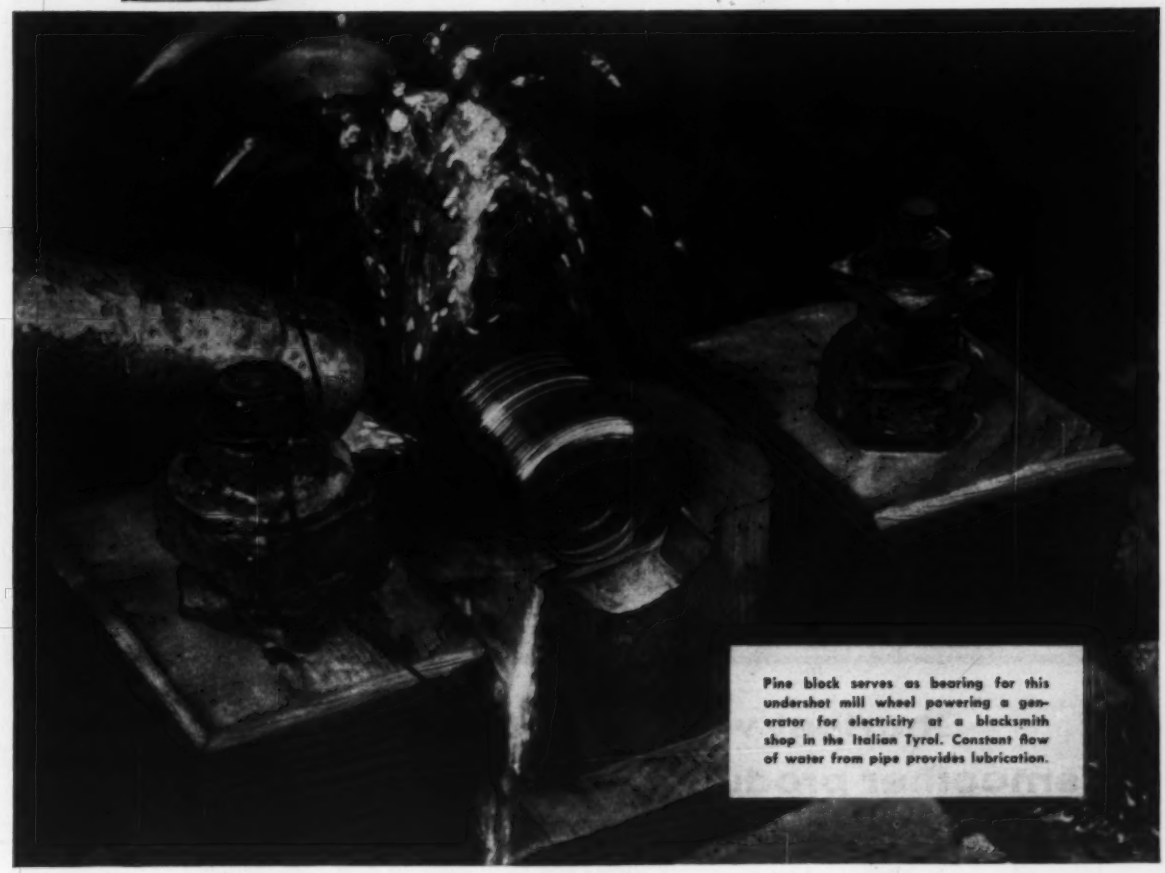

Pine block serves as bearing for this undershot mill wheel powering a generator for electricity at a blacksmith shop in the Italian Tyrol. Constant flow of water from pipe provides lubrication.

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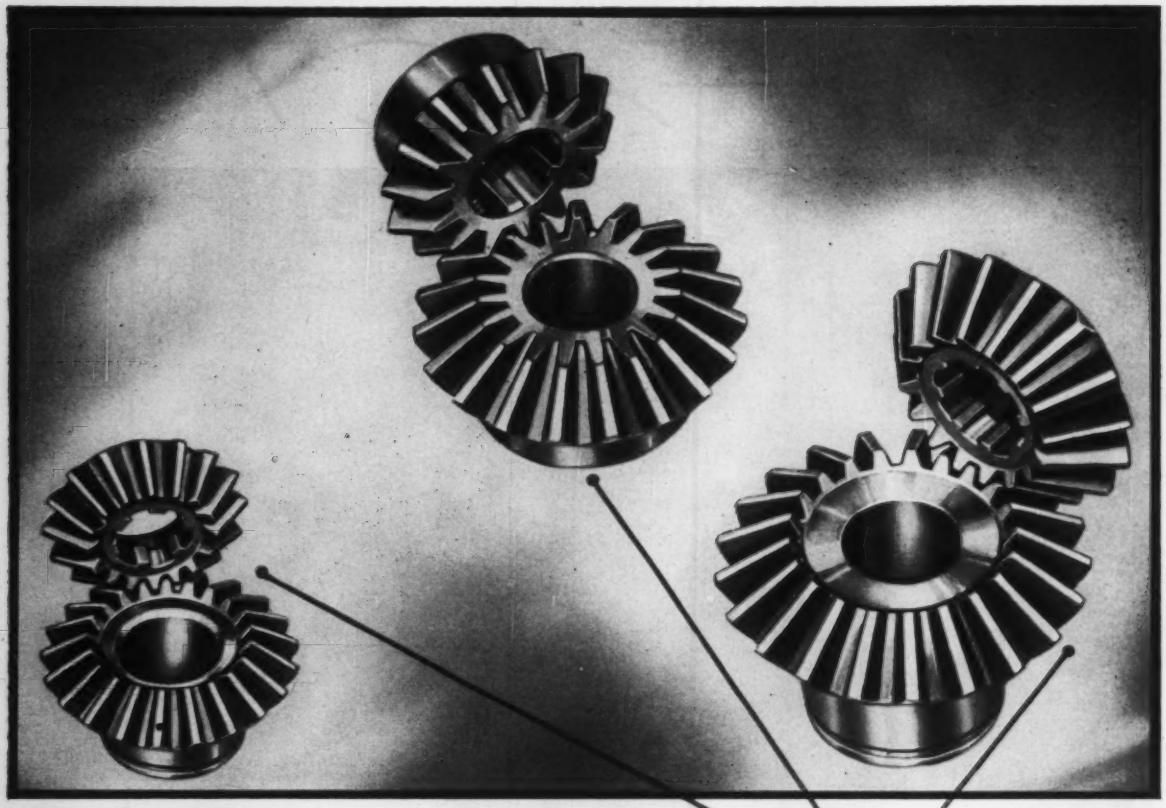

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MECHANICAL ENGINEERING

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"B&W Welded Stainless Steel Tubing resists corrosion because it is fully annealed and precision made

As a design engineer working with heat exchanger and condenser applications, I know the importance of selecting tubing that's fully annealed. That's why I choose B&W Welded Stainless Steel Tubing. It gives me resistance to corrosion, ease of fabrication and close tolerances that I want."

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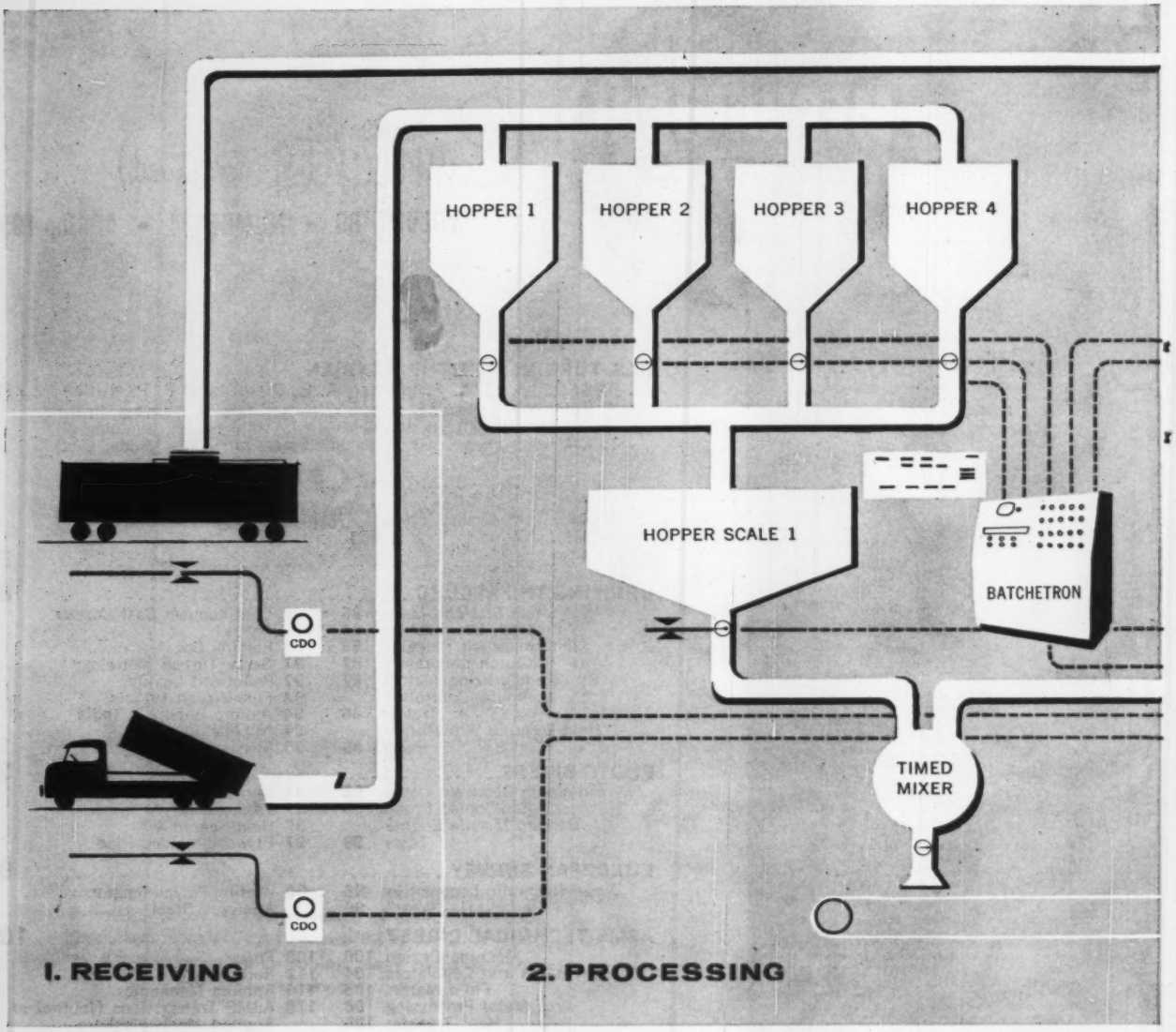

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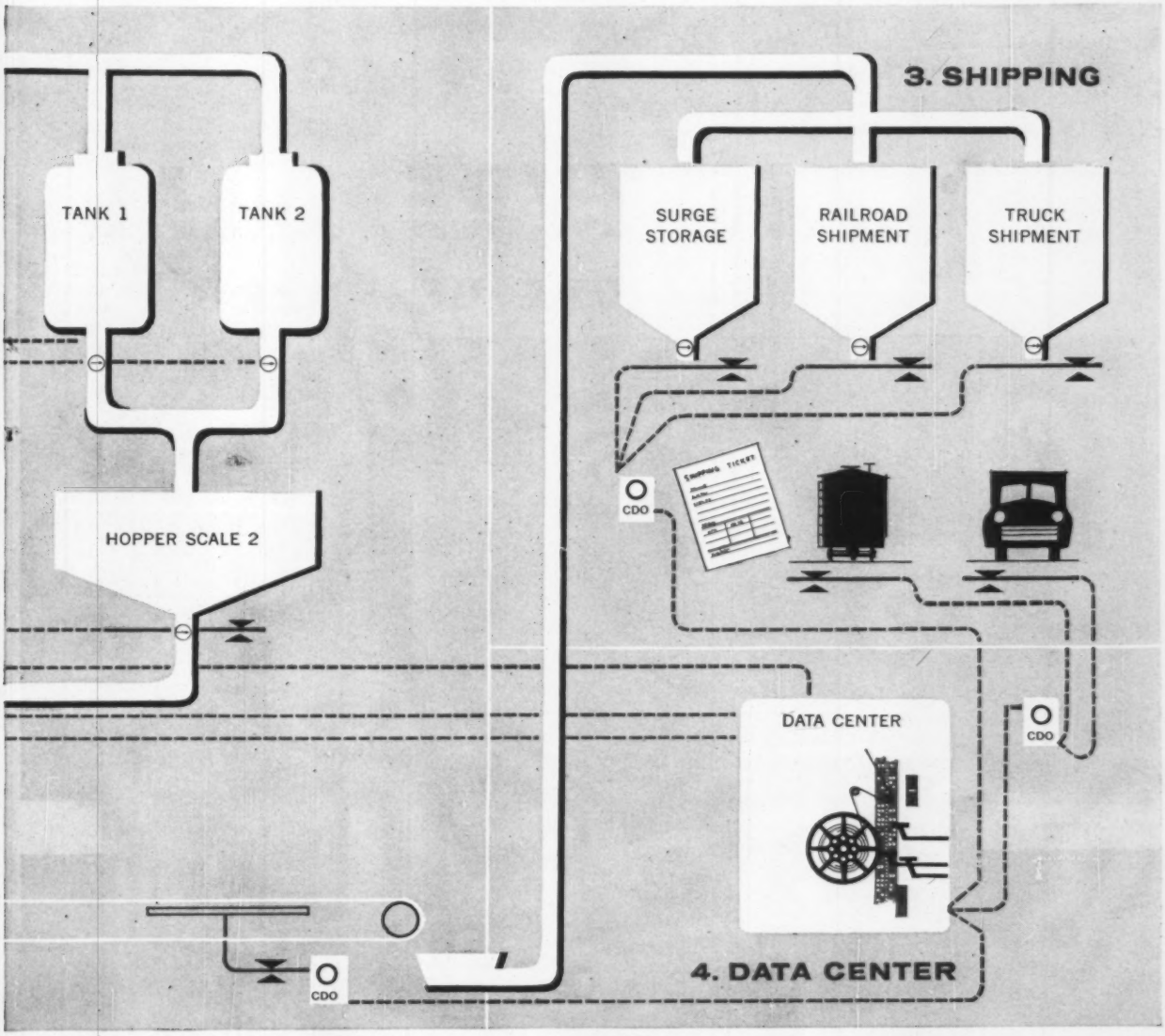

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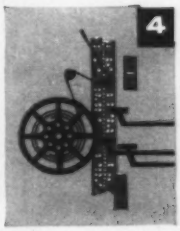

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A recent exhibit at the National Gallery features 10 of America's most modern buildings. The American Institute of Architects, on the occasion of its Centennial, included in the exhibit the new home office of the Connecticut General Life Insurance Company in suburban Hartford, which is equipped with Wickes boilers. This spacious, sun-flooded building of steel and glass, is nearly a modern city in itself, for it houses not only the complete office system, but includes employee lounges, game rooms, medical department, mailrooms, auditorium, bowling alleys, barber and beauty shops as well.

For the heating system in this mammoth structure, engineers chose to install two Wickes type S-1AL steam generators equipped with both oil and gas burners. In addition to general heating, the steam generators provide power to operate the refrigeration machines and a snow-melting system on the truck ramp. The boilers each have 3700 sq. ft. of heating surface, and were designed for a maximum continuous load of 27,500 pounds of steam per hour at 200 PSIG.

Bulletin No. 55-1 gives complete facts on Wickes products. New engineering bulletins on Type-S and Type-A Steam Generators are also available on request.

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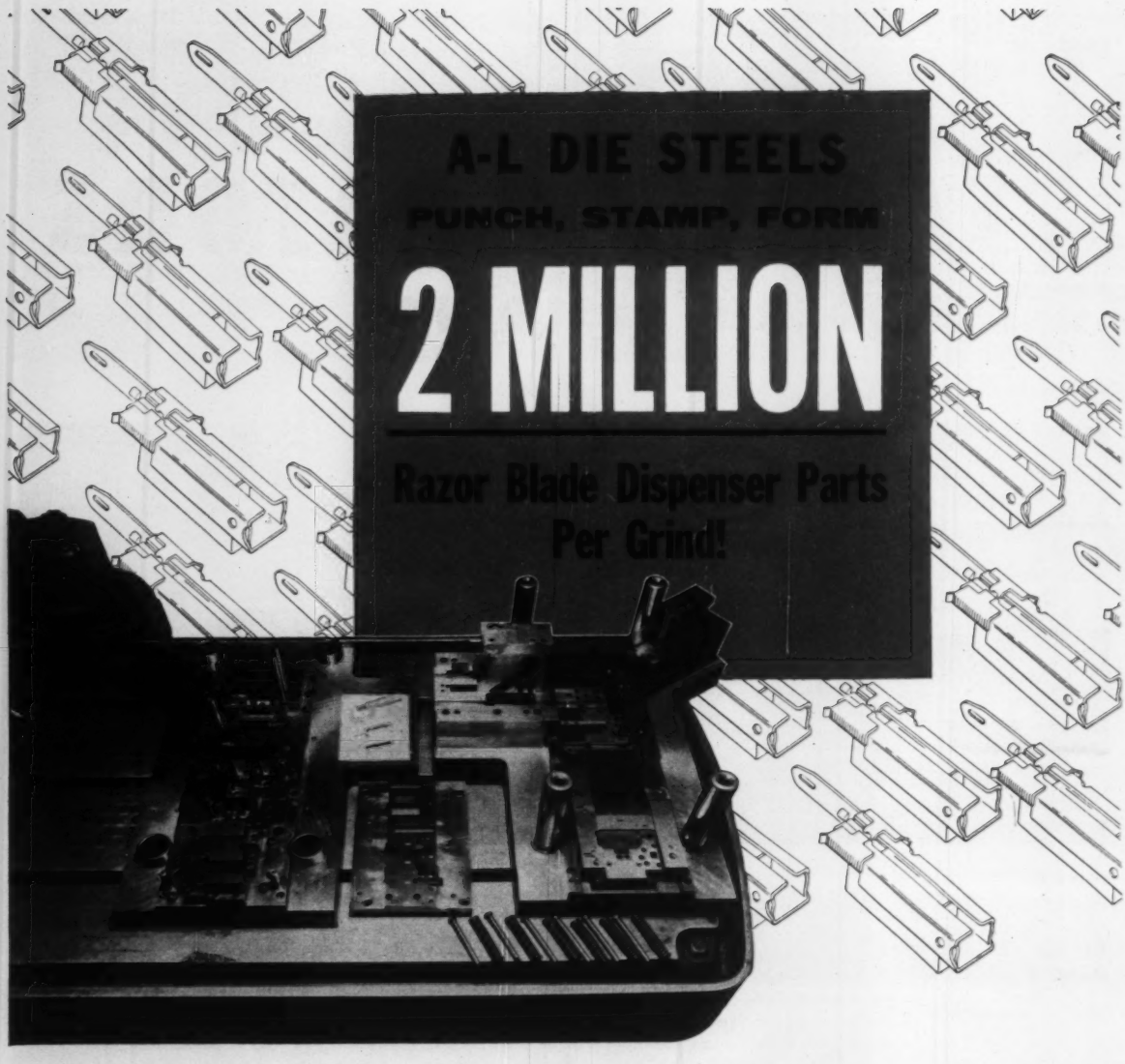

Punching, stamping and forming parts of this die are of air-hardening Allegheny Ludlum ONTARIO—heat treated to 61-62 Rockwell C. Slides, frames and cams are of A-L DEWARD oil-hardening die steel —heat treated to 61-62 Rockwell C.

Ontario sections were pre-heated to 1250 F, then heated to 1850 F, held at 1850 F for about an hour and a half, then quenched in still air to room temperature. Finally they were drawn at 350 F for about three hours.

Deward sections (slides, frames and cams), were pre-heated to about 1200 F, then raised to 1420 F. As soon as they were uniformly heated and equalized with the furnace temperature, they were quenched in warm oil. Sections were then tempered for two hours at 325 F.

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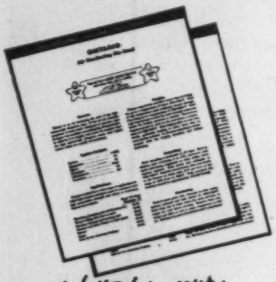

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Fabrication of the Type 316 Stainless main steam piping for Philadelphia Electric Company's new Eddystone Station, Unit No. 1, comes nearer to completion—in The M. W. Kellogg Company's Jersey City shops.

Designed for use at a record 5,000 psi-1200 F., these steam lines required the heaviest wall thicknesses ever used in Type 316 steam-electric plant piping.

To fabricate 2,400 ft. of such heavy-walled stainless piping to exacting specifications is, in itself, a task that few fabricators could be entrusted to undertake. For many years M. W. Kellogg has been testing and evaluating materials, and perfecting fabricating techniques, in conjunction with the foremost power companies and major equipment suppliers. This experience assures today's ultimate in operating efficiency.

Kellogg welcomes the opportunity to discuss its complete power piping design, fabrication, and erection facilities with consulting engineers, engineers of power generating companies, and manufacturers of boilers, turbines, and allied equipment.

Photo above, of section of Type 316 piping being welded, dramatically shows ratio of wall thickness to inside diameter. This section has already been bent, in rear, to a 90° angle. Below, welded joints of smaller section of Type 316 being ground to dimensions. The bend on this section is visible at left.

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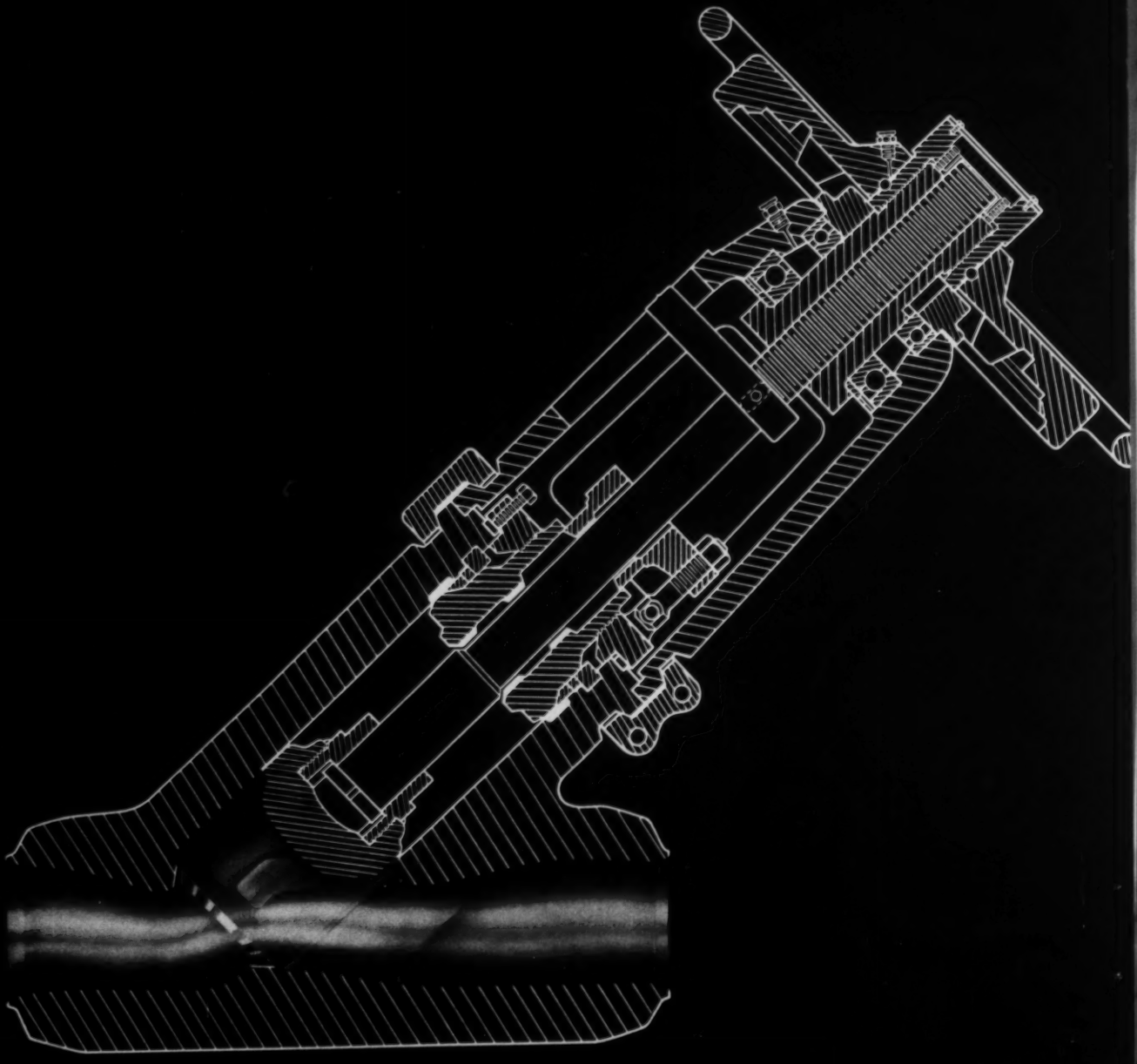

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New Flite-Flow* Valve Cuts Pressure Drop 70%

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Through basic characteristics of its design, only a hard seat globe-type valve can be depended upon to give drop-tight shutoff under high-pressure, high-temperature conditions. But conventional globe valves also produce serious pressure-drop problems—which intensify in the trend toward larger-capacity, higher-pressure plants with their higher-velocity flow rates.

Briefly stated, this was the problem given to Edward engineers. In their continuing program of valve development, these men had singled out turbulence in the flow path as a key area for study. They charted the effects of re-shaping flow passages . . . of shifting valve seat location . . . of *pre*-shaping the flow as it approaches the seat.

Low turbulence factor

All tests confirmed that total pressure drop was least when turbulence was minimized in the three most critical areas: ahead of, at *and beyond the seat.* In the final design, flow approaching the seat is pre-shaped to provide a special "squirting action" which carries the fluid smoothly across the seat. The downstream side of the passage is shaped to receive this flow and send it on with a minimum of eddy and turbulence.

The net result of years of research and development, Flite-Flow is available in sizes 10" and larger.

The result is Flite-Flow, a globe valve with drop-tight shutoff *and* negligible pressure drop, as shown in the tables below:

FEEDWATER SERVICE

In 500-F, 3000-psi feedwater service on a 1,500,000 lb/hr unit, the following performance of 12-inch valves has been recorded:

Ordinary globe valve . . . 10-15 lb drop
EDWARD FLITE-FLOW VALVE . . . 2.1 lb drop
Good gate valve . . . 1.0 lb drop

STEAM SERVICE

In 1050-F, 1900-psi steam service at 800,000 lb/hr through a 12-inch valve, the following performance has been recorded:

Ordinary globe valve...64 lb drop
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Good gate valve . . . 2 lb drop

OTHER IMPORTANT FLITE-FLOW FEATURES:

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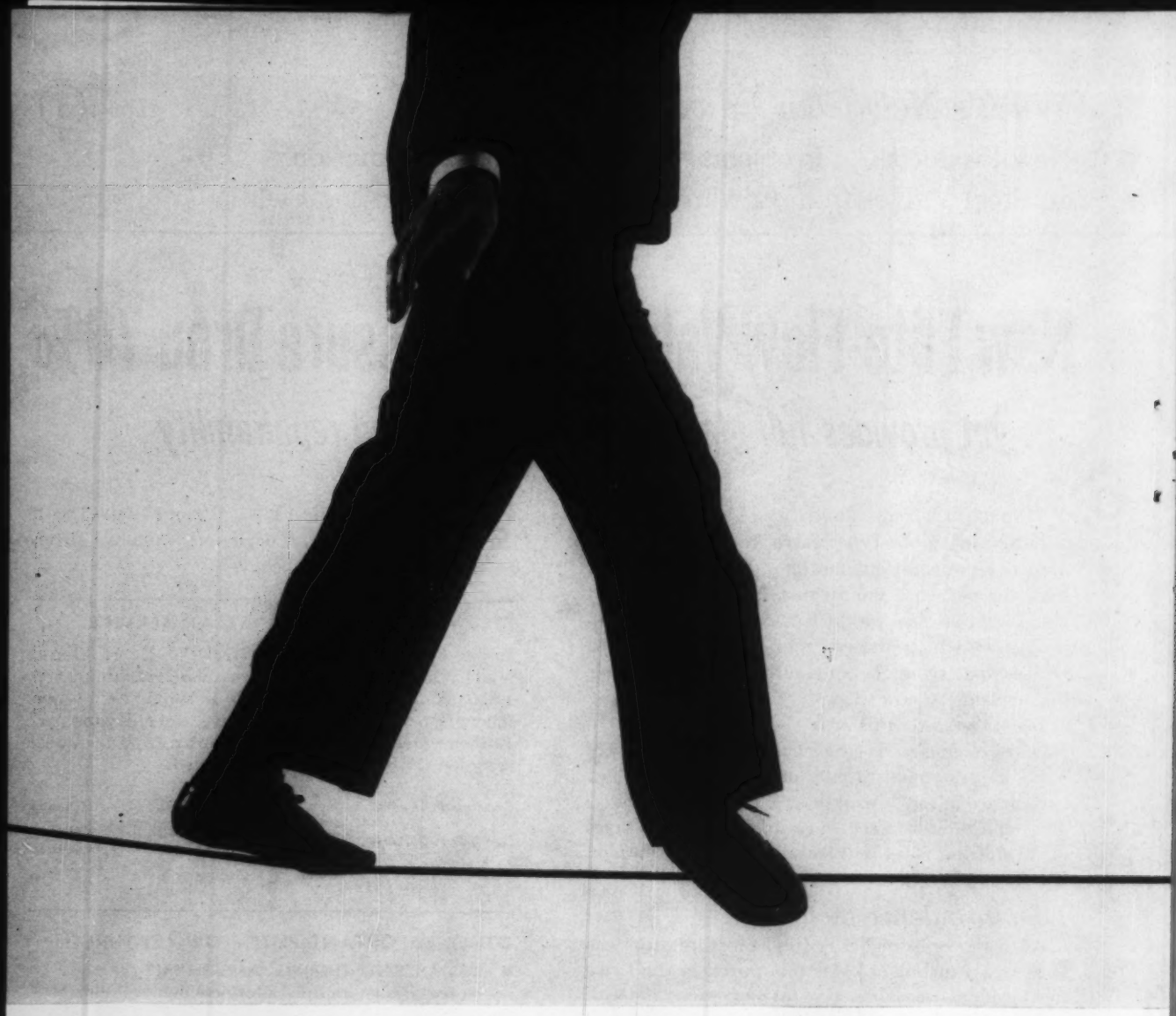


Strength—On an island off the coast of Greenland, you can find the remnants of three large meteorites which the Eskimos have named "The Tent," "The Woman" and "The Dog." Only about one half of the meteorite mass remains, because native warriors and craftsmen worked for untold centuries to rip away pieces of the heaven-sent alloy for vital weapons and tools. So it is today, that man first turns to steel when he needs a versatile metal of great strength.

If strength were the only consideration of the designer, his job would be simple: pick the strongest steel he can afford for the job. But invariably, he is enmeshed in a spider's web of other problems. He needs varying amounts of corrosion resistance, toughness, weldability, fatigue or wear resistance, formability. To cap it, he is asked to choose from a vast range of different steels, at different prices, with different combinations of properties. Then come the added complications of heat treating, and the fact that production techniques may have a profound effect on several important properties of the steel he has chosen.

But underlying all this, one fact remains: In theory, there is one best steel for any application. When you know the performance requirements and the cost problems, when you are intimately familiar with all the properties of all the available steels, you can usually settle on one that will result neither in overdesign nor underdesign. And you are almost certain to find that steel in the great family of USS Design Steels, a selection unmatched by any other producer in the world.

For careful design, when cost is a problem, the selection of the best steel should be made by a skilled metallurgist—either on your staff or ours. Write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS United States Steel

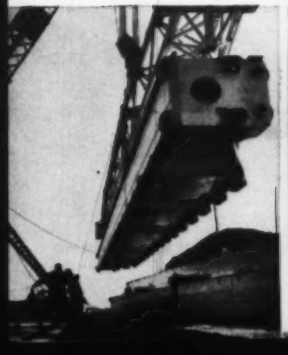
STEELS FOR DESIGN

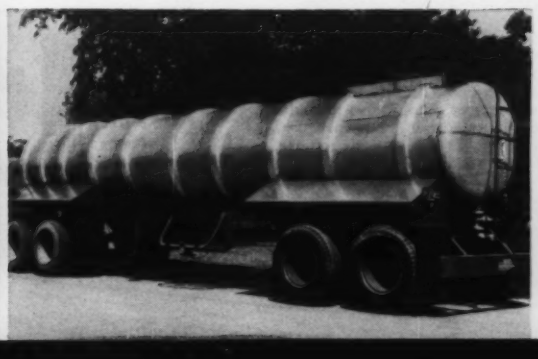
Lower Left—Problem: Several of the stop logs fabricated by Montreal Locomotive Works for the St. Lawrence Seaway's St. Lambert Lock had to be made extra-strong to withstand greater water pressure than typical of the other locks. But to insure ease of handling and interchangeability with the other logs, they couldn't be made larger. Solution: Logs were made of USS MAN-TEN Steel, one of several USS High Strength Steels. Benefit: MAN-TEN logs are much stronger, but have same weight and size as regular stop logs.

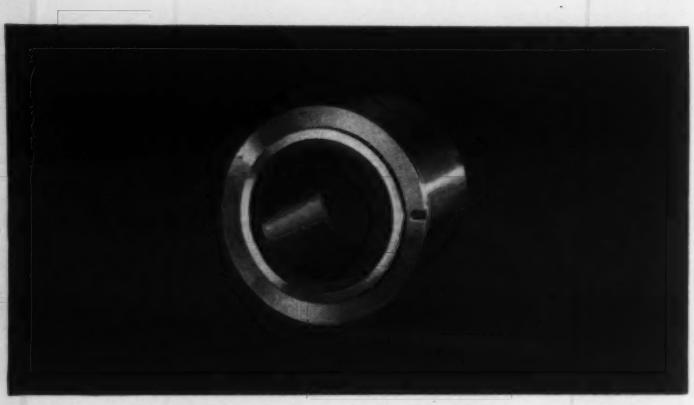
Lower Middle—Problem: On a lift truck, every pound of weight forward of the wheels reduces load capacity. Solution: Clark Equipment Co. designed lift truck carriage assembly from USS "T-1" Constructional Alloy Steel, reducing weight of assembly by 66%, compared to structural carbon steel. Benefit: Pay load was greatly increased, due to USS "T-1" Steel's 90,000 psi yield strength.

Lower Right—Problem: Heil Company wanted to design a very strong, corrosion-resistant tank trailer to haul corrosive solutions. Solution: Using Type 316 USS Stainless Steel, they developed the unusual ribbed design visible in the picture. Benefit: Stainless Steel's strength helped to give greater beam strength to the tanker. Its corrosion resistance allows the tank to be cleaned easily, so it can be used to haul different liquids on different trips.

USS, Man-Ten and "T-1" are registered trademarks



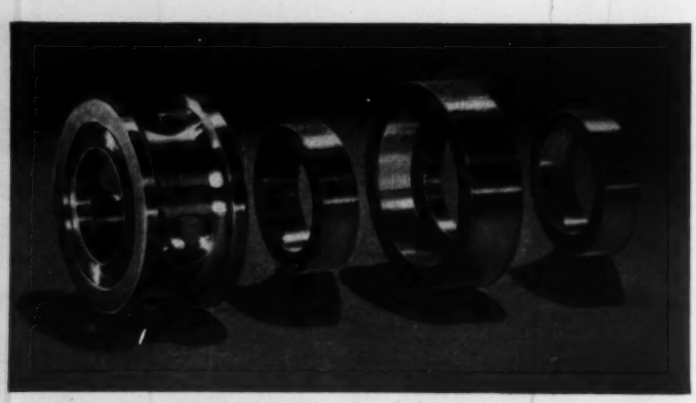




SINGLE BUSHING TYPE Floating Ring Seal

Seal Any Medium—Even Corrosive Media ... with Koppers Floating Ring Seal

MULTIPLE RING TYPE Floating Ring Seal (assembled)



FLOATING RING SEAL Basic Elements: Lantern Ring, Floating Ring, and Spacer Diaphragm. As sealing needs dictate, floating rings and spacer diaphragms are added. Seals are carbon, plastics, ceramics or steel, as applications require.

The Only "No Maintenance" Seal for Rotating, Oscillating and Reciprocating Motion

Koppers' precise, efficient Floating Ring Seal assures long seal life, low leakage, reduced wear, less power consumption, and decreased operating costs.

It seals at high temperatures and at pressures up to, and for some conditions even above, 2000 psi. Inspection has shown that after 10,000 hours of operation, ring and spindle wear can be negligible. For water at 500° F. and 1200 psig with a $\frac{5}{8}$" spindle, leakage is only one to two pounds per hour. Frictional power requirements are virtually zero, and Koppers' design reduces radial frictional restraint. Sealing members adapt to changes in the shaft's position.

Applicable to valve spindles, pumps, atomic reactor spindles and many other similar installations, Koppers Floating Ring Seal gives efficient, low-cost service for the sealing of all types of fluids under widely varying conditions of temperature and pressure.

For additional information, write to: KOPPERS COMPANY, INC., Piston Ring and Seal Department, 9304 Hamburg Street, Baltimore 3, Maryland.

KOPPERS

MECHANICAL SHAFT SEALS

Engineered Products sold with *Service*

ANOTHER FIRST FROM TUBE TURNS...

LIGHT WEIGHT FITTINGS for lower-cost piping

Light weight piping makes practical the use of larger pipe for greater flow area, and it cuts cost and weight. To enable you to take full advantage of the economies of "thin wall" steel piping, Tube Turns offers a complete line of light weight fittings. TUBE-TURN* Light Weight Welding Fittings are produced under the same exacting quality control standards as the 12,000 other items in the Tube Turns' line. They are available promptly from your nearby Tube Turns' Distributor.

(continued on next page)

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

Louisville 1, Kentucky

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

Available in nominal sizes from 4" through 24" . . . in wall thicknesses of .188, .219 and .250 inch. Also, 125 lb. light weight taper face welding neck flanges in sizes 2"—12" inclusive.

How you can cut costs with

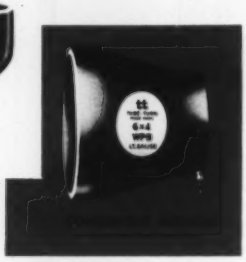
TUBE-TURN® LIGHT WEIGHT WELDING FITTINGS

A typical user of light weight steel piping reports these benefits: 100 feet of 8" x .188" wall pipe costs about $10 less than 100 feet of 6" standard weight pipe • Increases flow area 85% • Cuts piping weight about 10% • To enable you to take full advantage of these economies, Tube Turns offers a complete line of light weight fittings. They are forged from seamless pipe. Meet all code requirements. Uniform wall thickness and true circularity permit field cutting of odd angles. Available promptly from Tube Turns' Distributors in all principal cities. Complete details in Bulletin TT 867, free on request.

The trademarks "tt" and "TUBE-TURN" are applicable only to the quality products of Tube Turns.

45° ELBOW

CAP



125 LB. W.O.G. TAPER FACE WELDING NECK FLANGE (PATENT PENDING)

Available from your nearby TUBE TURNS' Distributor

TUBE TURNS
224 East Broadway, Louisville 1, Kentucky

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Position _____

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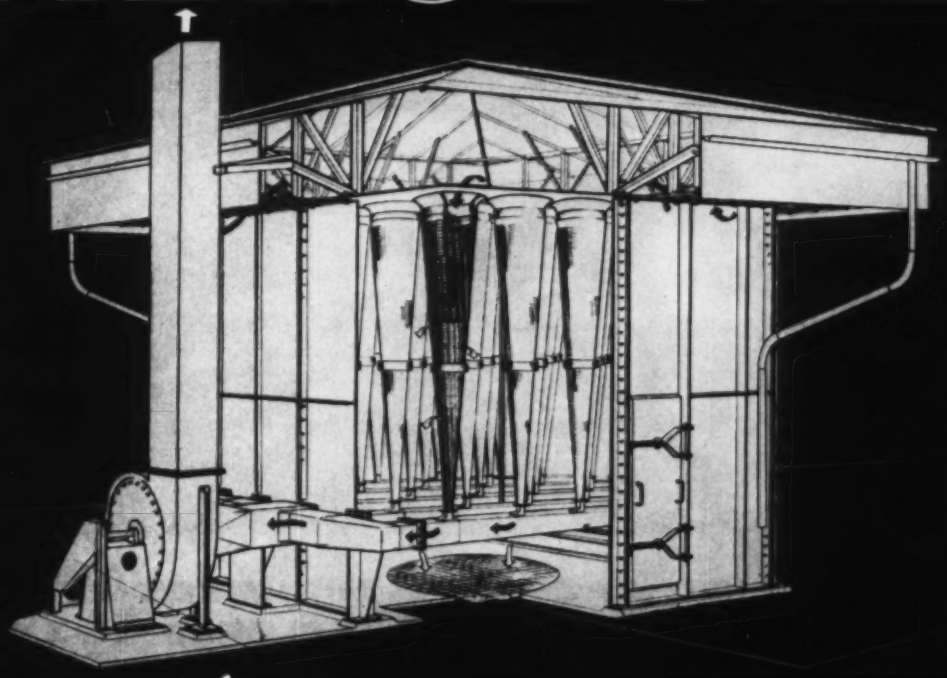

Checks **FAN BLADE CUTTING AT INLAND STEEL**

Blade erosion in Turbo-Blowers is extremely expensive. Atmospheric air in a steel plant contains a large amount of abrasive particles that can be efficiently removed by an Aerodyne Dust Separator that combines

- **Low installation cost,**
- **Low draft loss,**
- **Small space requirement,**
- **Negligible maintenance cost,**
- **High efficiency for abrasive particles.**

The 125,000 CFM Aerodyne at the Inland Steel Company, Indiana Harbor Plant, East Chicago, Indiana, recovers 100-200 pounds of dust every week and blade erosion is cut to a minimum.

Perhaps you, too, are having blade-cutting problems on the blowers supplying air to your blast furnaces? Ask to have one of our engineers call to discuss the problem.

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FUEL ECONOMIZER CO., INC.
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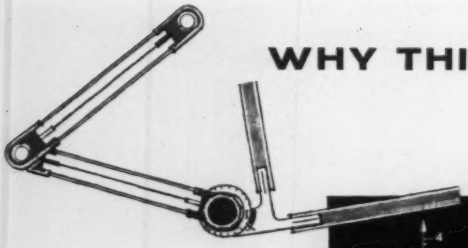
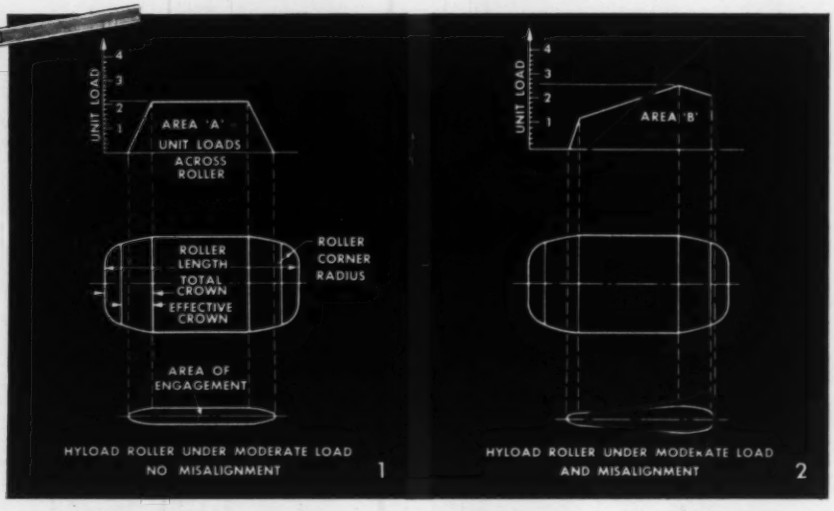


WHY THINGS RUN SMOOTHER WHEN YOU SPECIFY HYATTS

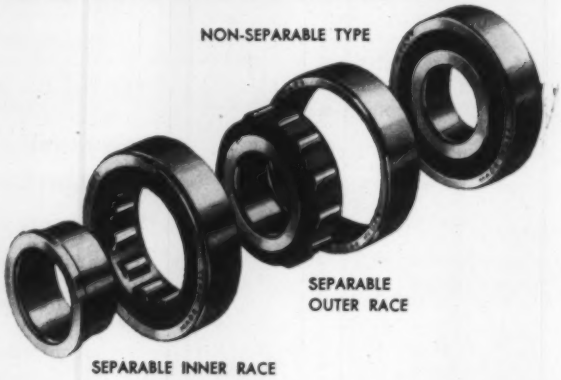


HY-LOAD ROLLER CROWNING MINIMIZES EFFECTS OF MISALIGNMENT—LENGTHENS BEARING LIFE

In any roller bearing, the design and quality of the rollers themselves vitally affect the performance of the entire bearing. The distribution of the load across the roller's full area of contact must be carefully controlled. End-loading and conditions of misalignment can seriously reduce the life of a roller bearing. How HYATT minimizes these effects is detailed at the right.

You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, N.J., Pittsburgh, Detroit, Chicago and Oakland, California

The unit load on any roller is distributed axially in a uniform manner except at the ends where crowning has been provided. Figure 1 shows how the unit load drops off to zero at the ends of the area of contact. The summation of unit loads represented by area "A" is the total roller load. This same load under conditions of misalignment (Figure 2) must result in an area "B" equal to area "A"; but the maximum unit load is considerably greater and the misaligned bearing will therefore have a shorter life. However, if the same total load is applied to an uncrowned roller in a misaligned bearing, as shown in red, a much higher maximum unit load (area "C") results, and would reduce the life of the bearing. This demonstrates why HYATT Hy-Load Series Bearings with roller crowning run smoother and longer even under conditions of misalignment.



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Easier Printmaking . . .

Big, new operating features

The Printmaster 810

Here's the advanced Printmaster 810—with features that outdate every other whiteprinter in its price class. Now you can assure yourself of better whiteprints, more easily, in less time.

1. **More compact—lower in height** . . . saves valuable floor space, allows easier lamp replacement, better control . . . means less fatigue.
2. **New design of brush feed assembly** . . . to automatically control curled edges, folded corners.
3. **New print pick-off** . . . prevents tearing, sticking or scratching.
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6. **New filtered air system** . . . Fiberglas® filter delivers filtered air—for cleaner machine, cleaner prints—means less shut-down time for cleaning.

And Ozalid offers other great *proven* features such as new steel frame support . . . double paper rods . . . both rear and front delivery . . . and U/L approved safety devices.

Why not test-run your own tracings through the new "810"? Simply call your local Ozalid representative or write: Ozalid, Dept. U-4, Johnson City, N. Y.

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First Name in Whiteprinting

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NEWS!

AVAILABLE FROM SHELF STOCK –

TAYLOR POTENTIOMETER TRANSMITTERS

CALIBRATED TO YOUR SPECS.

NOW we can offer you immediate delivery of the 700T Taylor TRANSET* Potentiometer Transmitter—custom-equipped for your specific application. **It's the unique** plug-in features of this instrument—plug-in amplifier, plug-in transducer, plug-in service "cans"—that make it so superior and so readily adaptable to your needs. *And it's these same benefits of flexibility that permit us to fill your orders so promptly.*

Plug-in service "cans" means that the instrument can be quickly adapted for use with different primary elements by simply plugging in the corresponding can. (For thermocouple applications cold junction compensation is provided in the can).

Just one amplifier. You change its service by switching service cans. Both the amplifier and the transducer plug-in . . . means minimum instrument down-time for service. Also means low instrument inventory because you only need one spare amplifier.

*Reg. U.S. Pat. Off.

Check these additional benefits: • Infinitely sensitive to input signal. • High order of linearity and accuracy. • No moving parts such as slidewires, batteries, or standard cell. • Continuous vernier range adjustment. • Continuous vernier zero or suppression adjustment. • Convenient front panel checkout and adjustment. • Printed circuit, for completely uniform performance. • Thermocouple burnout protection, either up or down scale.

Acknowledged by users as the finest instrument of its kind on the market, the TRANSET Potentiometer is ideal for processes permitting the use of pneumatic receivers and controllers, whether large case or miniature. Its outstanding flexibility permits a narrow or wide range span according to process demands.

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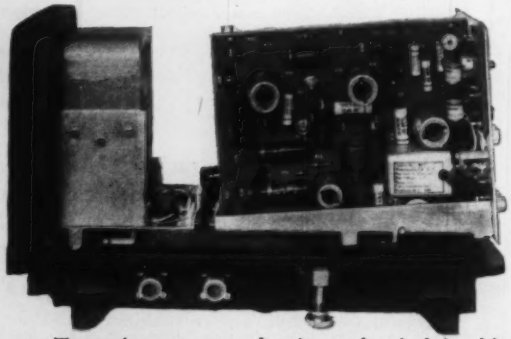
Call your Taylor Field Engineer, or write for **Catalog 98262.** Taylor Instrument Companies, Rochester, N.Y., or Toronto, Ontario.



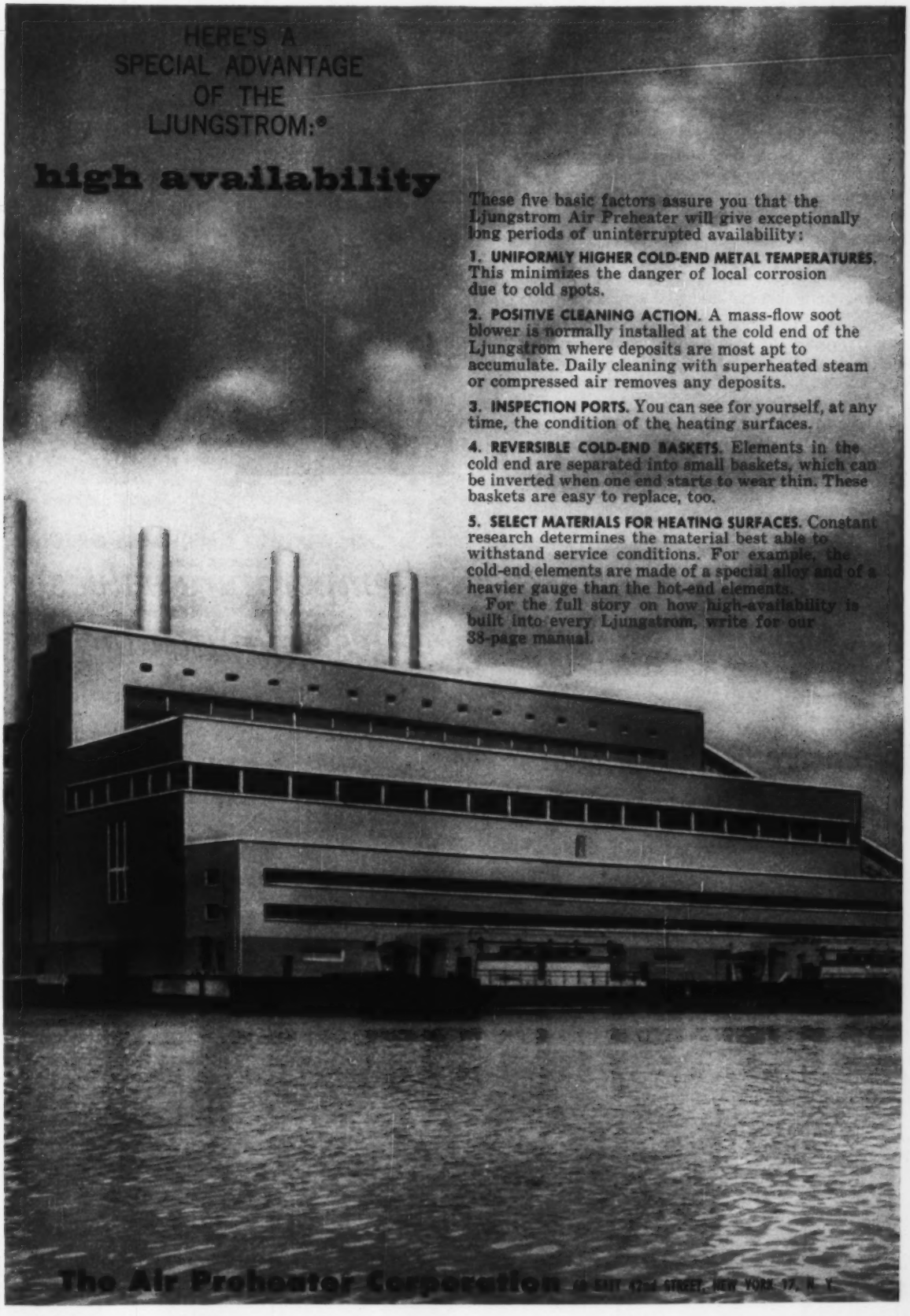
Transmitter converts a dc primary electrical signal into a 3-15 psi pneumatic output for controllers and receivers.

INSTRUMENTS IN STOCK WITH THESE PRIMARY ELEMENTS

THERMOCOUPLE . . . *Copper-Constantan . . . Iron-Constantan . . . Chromel-Alumel*

VOLTAGE . . . *For pH; strain gages; tachometers; 0-50 mv.*

Taylor Instruments MEAN ACCURACY FIRST


HERE'S A
SPECIAL ADVANTAGE
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LJUNGSTROM:*
high availability
These five basic factors assure you that the Ljungstrom Air Preheater will give exceptionally long periods of uninterrupted availability:
1. UNIFORMLY HIGHER COLD-END METAL TEMPERATURES. This minimizes the danger of local corrosion due to cold spots.
2. POSITIVE CLEANING ACTION. A mass-flow soot blower is normally installed at the cold end of the Ljungstrom where deposits are most apt to accumulate. Daily cleaning with superheated steam or compressed air removes any deposits.
3. INSPECTION PORTS. You can see for yourself, at any time, the condition of the heating surfaces.
4. REVERSIBLE COLD-END BASKETS. Elements in the cold end are separated into small baskets, which can be inverted when one end starts to wear thin. These baskets are easy to replace, too.
5. SELECT MATERIALS FOR HEATING SURFACES. Constant research determines the material best able to withstand service conditions. For example, the cold-end elements are made of a special alloy and of a heavier gauge than the hot-end elements.
For the full story on how high-availability is built into every Ljungstrom, write for our 38-page manual.
The Air Preheater Corporation 60 EAST 42nd STREET, NEW YORK 17, N. Y.

CRANE Pressure-Seal Bonnet Valves

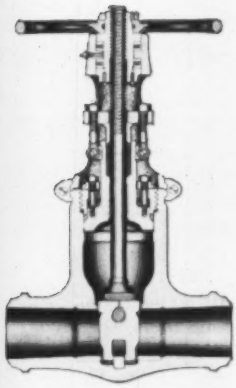
In gate, globe, angle and stop-check patterns—flanged, butt- and socket-welding ends—rated in accordance with A.S.A. in 600-, 900-, 1500- and 2500-pound classes. Sizes: gates—1 to 24 inches; globes and angles—1 to 16 inches; checks—2½ to 12 inches; stop-checks—6 to 12 inches

Crane design is at its very best in this streamlined line of pressure-seal bonnet valves—made expressly for high-pressure/high-temperature service in central stations and industrial power plants.

Bonnet joints in these valves are sealed by a unique method which uses *internal fluid pressure* to effect a leakproof seal. This method virtually eliminates bonnet-joint maintenance—and maintenance costs.

Other features include: weight-saving body design—saving up to 60% over conventional design—swivel action yoke and clamp which permits choice of position for motor or gear mechanism . . . one-piece sealing ring . . . Stellited seating surfaces.

Write to address below for descriptive Circular 1936.



CRANE *high-pressure/temperature valves assure leakproof service—less maintenance*

CRANE Lip-Seal Bonnet Valves

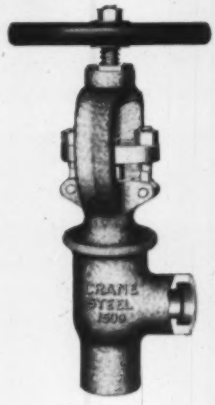
In globe, angle and lift-check patterns; sizes—½ to 2 inches; screwed and socket-welding ends; rated in accordance with A.S.A. in 1500- and 2500-pound pressure classes

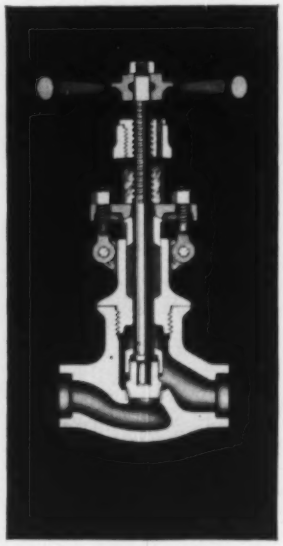
These popular Crane valves are widely used on steam, boiler feed, drips, drains, by-pass, blowdown and similar piping services.

They assure you absolute tightness, no bonnet-joint maintenance, minimum valve weight and bulk without sacrificing strength—and easy, fast dismantling and reassembly.

Features include: lip-seal design which permits re-welding without damage to the valve . . . improved disc-stem connection that minimizes vibration . . . two-piece, non-binding ball-type gland construction . . . and Stellite seating surfaces.

For details, write to Crane Co., for Circular 2099.





For prompt personal service, see your Crane Representative.

CRANE VALVES & FITTINGS

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NEW REFERENCE MANUAL

... to help you choose dependable high-speed gear units

Here is one of the handiest manuals on high-speed gear units ever offered. It covers both speed-increasing and speed-reducing units.

Every one of its 28 pages is designed to help you in the efficient selection and application of Farrel SI units. Concise yet complete, the booklet makes it easy for you to choose the proper unit for long service life and trouble-free operation. Diagrams illustrate twelve alternative lubrication systems designed to meet individual requirements.

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- Description of the units
- General specifications
- Instructions for selecting a unit
- Selection examples
- Table of ratio factors
- Service factor table
- Table of horsepower ratings
- Ordering instructions
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Engineers will find this factual manual useful in the selection of drives for a variety of applications. Send the coupon for your free copy.

FARREL-BIRMINGHAM COMPANY, INC., Ansonia, Conn.

Please send me a copy of Bulletin 451, "FARREL HIGH-SPEED GEAR UNITS."

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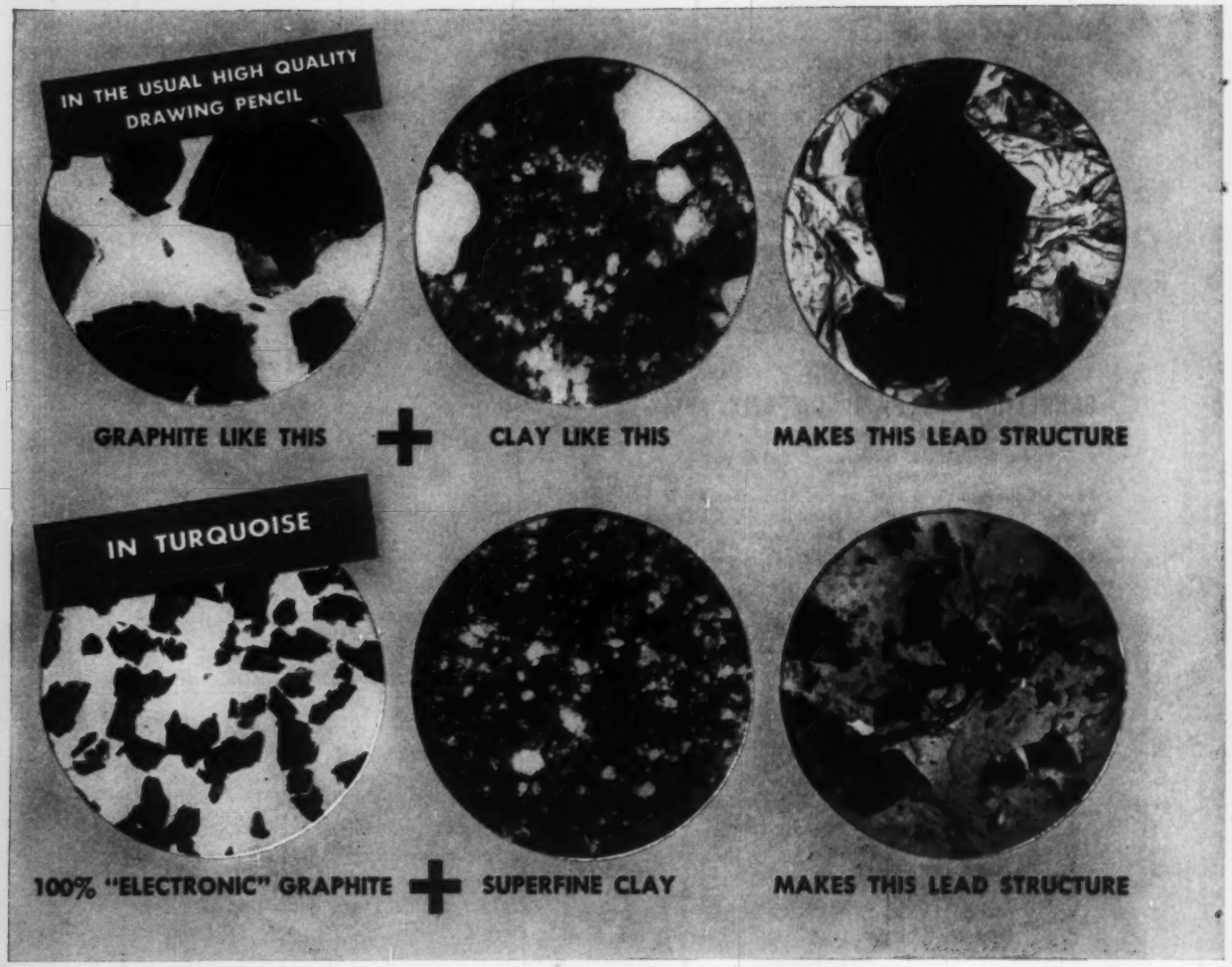
Now you can see why only leads & pencils give you perfect



YOU ALWAYS GET PROVEN QUALITY FROM TURQUOISE DRAWING LEADS AND PENCILS

PROVEN GRADING -17 different formulae make sure you get exactly the line you expect—from every pencil, every time.

PROVEN DURABILITY—Because compact lead structure gives off no chunks of useless "dust" to blow away, Turquoise wears down more slowly.

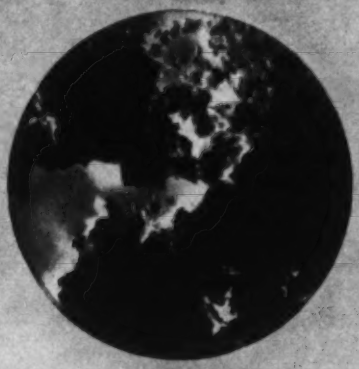
PROVEN NEEDLE-POINT STRENGTH—as electron photomicrograph shows, Turquoise lead structure is finer—and therefore stronger. It holds a needle point under drawing pressures for long lines of unchanging width.

EAGLE PENCIL COMPANY • NEW YORK • LONDON • TORONTO • MEXICO • SYDNEY • BOGOTA

Eagle Turquoise reproduction

THIS ELECTRON MICROSCOPE TAKES PERFECT PICTURES 7,500 TIMES ACTUAL SIZE— lets you see the startling difference between Eagle's "Electronic" Turquoise lead and the lead in the usual quality drafting pencil.

Photographs courtesy of Ladd Research Industries, Inc.



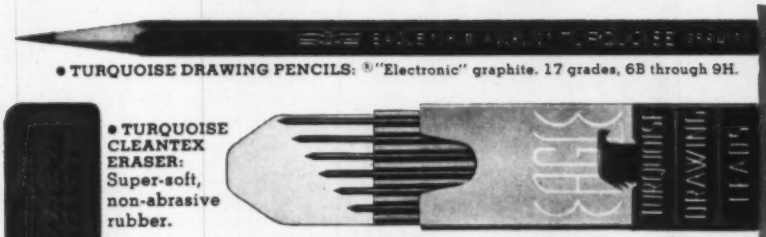
...AND MARKS LIKE THIS

Relatively large, irregular particles of graphite make a rough-edged line with gaps that permit the passage of light. Prints will be inferior.

...AND MARKS LIKE THIS

Tiny, more uniform particles deposit as a clean-edged, solid opaque line that blocks the light and reproduces to perfection.

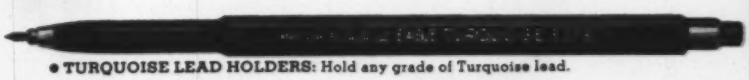
WRITE FOR FREE SAMPLE DEMONSTRATION KIT
(including Turquoise wood pencil, Turquoise lead, and Turquoise "skeleton" lead) naming this magazine. Eagle Pencil Company, 703 East 13th Street, New York, N. Y.



• **TURQUOISE DRAWING PENCILS:** ®"Electronic" graphite. 17 grades, 6B through 9H.

• **TURQUOISE CLEANTEX ERASER:** Super-soft, non-abrasive rubber.

• **TURQUOISE DRAWING LEADS:** Fit any standard lead holder. Grades 5B through 9H.



• **TURQUOISE LEAD HOLDERS:** Hold any grade of Turquoise lead.

EAGLE® TURQUOISE®
PENCILS AND LEADS
are the largest-selling in the United States!

rigid specifications

Tension tests are required to be made at room temperatures and at 670° F. The following minimum physical properties shall be met:

At Room Temperature:

TS	YS	EL	RA	CHARPY V-NOTCH
70,000	30,000	45	50	50

At 670° F. the minimum tensile strength shall be 51,000 p.s.i. and the minimum yield strength 18,300 p.s.i.

Rejection

Each casting that develops unacceptable defects during shop working or fails to conform to all of the requirements of these specifications shall be rejected. No repair by welding or other means will be permitted.

Radiographic Inspection

(a) Paragraph S5 (a) of the Supplementary requirements of ASTM-A 362-52T.

(b) All castings shall be radiographed 100% and shall conform to ASTM-E7 1-52, Class 2 quality, except as modified by these specifications.

(c) The manufacturer shall establish a positive system of identification of the X-ray plates which shall be subject to approval by the inspector. This system shall guarantee complete coverage by radiographing and provide for positive identification between the plate and the subject.

Inspection of Penetrants

All castings shall be subjected to inspection by fluorescent penetrants or penetrating dyes both inside and out. All cracks, porosity, or flaws revealed as a result of the Dye Penetrant Test shall be due cause for rejection of the casting.

All cast pipe shall be hydrostatically tested to 5,900 p.s.i. and held at that pressure for 20 minutes with zero pipe leakage. Each length of pipe shall be hydrostatically tested at the manufacturer's plant.

The 304L stainless steel shall conform to the following ladle analysis:

Carbon	.03 max.		
Manganese	1.50% max.		
Phosphorous	.03% max.		
Sulphur	.03% max.		
Silicon	2.00% max.		
Chromium	18.00	-	21.00%
Nickel	8.00	-	11.00%

Pipe: All pipe of the following sizes shall be centrifugally cast stainless steel as per ASTM-A 362-52T, except as modified by these specifications:

16" - Sch. #160
12" - Sch. #160
10" - Sch. #160
8" - Sch. #140

All pipe shall be machine finished to 125 micro-inch interior and exterior.

for nuclear piping met by U.S. PIPE metal mold process

Centrifugally Cast Stainless Steel Solves Many Piping Problems

Combinations of temperatures, pressures and corrosive conditions never encountered before: these are among the piping problems that must be overcome by the men who design the nation's nuclear power installations.

Stainless steel centrifugally cast pipe provides many of the answers. Study the specifications at the left . . . specifications demanded of stainless steel pipe on a recent job for Paul Hardeman, Inc., Los Angeles, California. This pipe is being used for heavy duty, high pressure, elevated temperature service in the primary piping system of the SPERT-III Reactor at the U.S. Atomic Energy Commission's National Reactor Testing Station near Idaho Falls, Idaho. The Stearns-Roger Mfg. Company, Denver, Colorado, is the architect-engineer on this project. A complete tabulation of the actual test data obtained on this pipe and to this specification is available upon request.

U. S. Pipe is headquarters for metal mold centrifugally cast alloy and stainless steel pressure pipe over a wide range of special and standard analyses—in large and small quantities—and to individual specifications.

If piping of the type described above is the bottleneck in your nuclear power planning, write and outline the problem.

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter—6" to 50"

Wall Thickness—⅜" and up

Length—Up to 16'

Types of Stainless—All Standard AISI and ACI grades of ferritic and austenitic stainless, including No. 20 Alloy, 17-4 P H, 17-7 P H and E.L.C. grades.

UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

BURLINGTON, NEW JERSEY

STEEL & TUBES U.S. PIPE DIVISION

SALES OFFICES: LOS ANGELES, SAN FRANCISCO, CHICAGO, ST. LOUIS, COLUMBUS, PITTSBURGH, WATERTOWN, BURLINGTON

Telephone

manufacturer calls for coal

Automatic Electric Co. burns coal in new plant because of cost and availability

Modern facilities, modern products, modern fuel—you'll find all three at the new Northlake, Ill., plant of Automatic Electric Co., manufacturing subsidiary of General Telephone. The power house of this communications equipment plant (designed and built by The Austin Company of Cleveland) is as modern and efficient as the manufacturing process itself. The plant required large quantities of economically and reliably produced steam for process work and heating. The fuel selected was *coal*, because of coal's economy and abundant supply. As a result, today Automatic Electric enjoys dependable, low-cost steam.

Facts you should know about coal

You'll find that bituminous coal is not only the lowest-cost fuel in most industrial areas, as in the case of Automatic Electric, but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment can pare labor costs and eliminate smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with industrial fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send the coupon below for case histories, complete with data sheets. You'll find them informative.

Consult an engineering firm

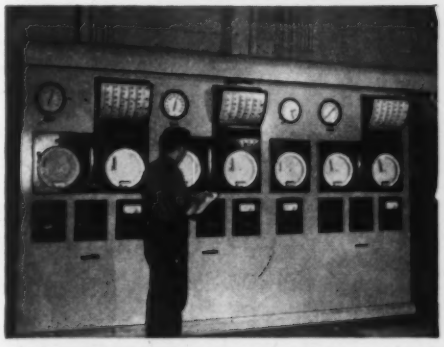
If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

Department ME-04

Southern Building • Washington 5, D.C.

Shown are two of the three Keeler boilers – fired by Detroit Spreader Stokers – in the power plant. At the right is the 22,000 lb/hr boiler. In the background is one of the 50,000 lb/hr boilers. The two sizes allow flexibility in operation for widely varying load requirements.



Control panel by Hays Corporation. This system regulates all operations of the boilers—steam pressure, draft, flue gas temperature, banking periods, etc. —to give complete, automatic control of steam generating operation.

Ash disposal system, by United Conveyor Co., in basement of boiler room. Ash is removed from furnace by Detroit CC grate, drops into hoppers in basement and is taken by vacuum to silo.

The Bituminous Coal Institute now has available a free booklet adaptable for design loads 3,000 to 24,000 EDR steam. This booklet, "Guide Specifications for Typical Low-Pressure Commercial Heating Plant," contains specifications, drawings and tables on all aspects of a typical heating plant. Send in this coupon for your copy.

☐ Guide Specifications Booklet ☐ Case histories on larger plants.

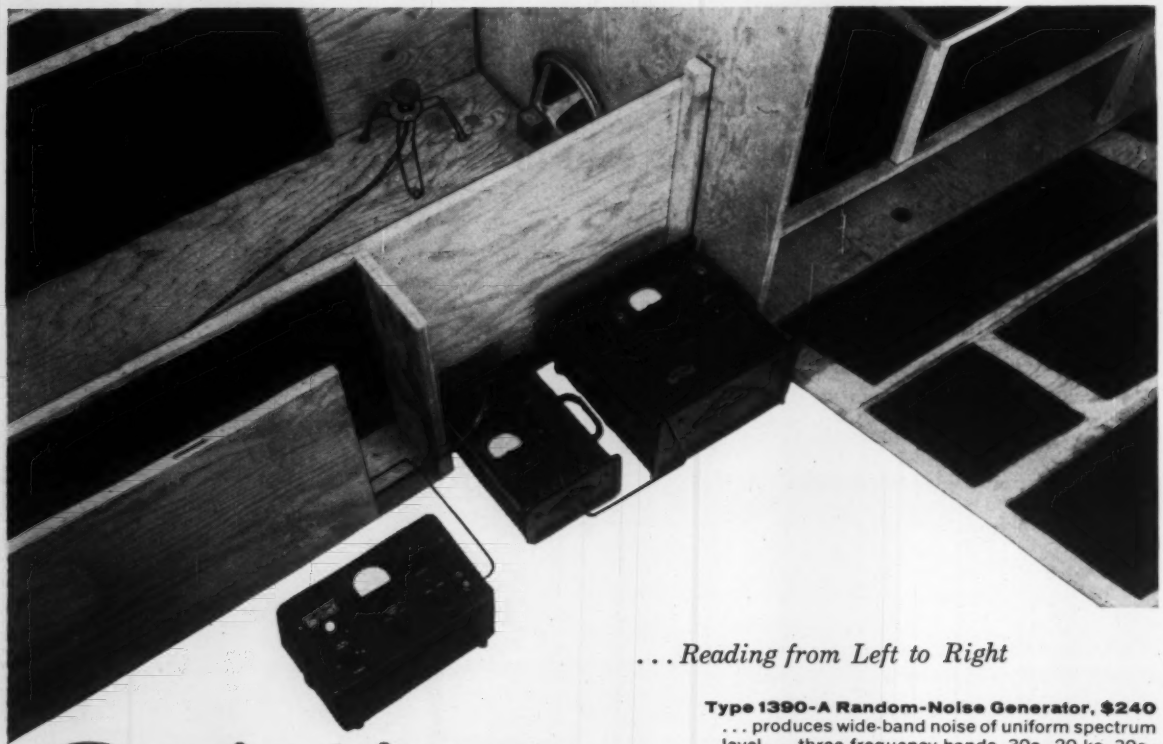
Name .....

Title .....

Company .....

Address .....

City ..... Zone ..... State .....



. . . Reading from Left to Right

Quieting
Jet-Engine Test Cells

A familiar technique has been applied by the Armour Research Foundation to the design of jet-engine test cells. By first constructing scale-model cells, and then testing them, costly mistakes in the finished structure are minimized. Optimum design for protection of operating personnel is thus assured.

For measurement purposes, a loud speaker driven by a General Radio Random-Noise Generator represents the jet-engine exhaust. A movable microphone samples the noise within the cell and passes this signal on to an Octave-Band Noise Analyzer which determines the sound energy in various bands of the audio spectrum. The model's dimensions and chamber configuration are easily altered to determine the effect of such changes on the sound field.

It is interesting to note that for a model built to 1/10th scale, a speaker test frequency of 1000c gives information as to the full-sized cell's ability to absorb 100 cycles — 10,000c represents 1000c under full-scale conditions, etc. The ten-to-one division in frequency permits measurements well below the lower frequency limits of the measuring equipment.

This application is but one example of the effectiveness of the Random-Noise Generator used in conjunction with G-R sound-measuring equipment. The combination is extremely useful for evaluating the performance of products and personnel in the presence of a variety of acoustical disturbances.

Type 1390-A Random-Noise Generator, $240 . . . produces wide-band noise of uniform spectrum level . . . three frequency bands, 30c - 20 kc, 30c - 500 kc, and 30c - 5 Mc . . . amplitude distribution of output closely approximates normal probability distribution of speech, music, and many other sounds and electrical disturbances that occur naturally. This instrument is widely used for room acoustics studies, psycho-acoustics work, testing communications equipment for susceptibility to electrical noise and interference, and for simulating vibrations of aircraft and other mechanisms.

Type 1551-A Sound-Level Meter, $395 . . . basic tool of the G-R sound-measuring line . . . reads directly sound-pressure levels from 24 db to 140 db, and to 190 db with accessory high-level microphones . . . built-in weighting networks as specified in A.S.A. standards . . . internal calibration system permits convenient, rapid standardization . . . instrument is light in weight, dependable, compact, and completely self-contained.

Type 1550-A Octave-Band Noise Analyzer, $535 . . . for rapid, accurate analysis of broad-band sounds (rattles, buzzes, hisses) whose sound energies are widely distributed over the audio spectrum . . . 8 bands cover the frequency range from 20 to 10,000 cycles; meter readings are simply added to settings of a calibrated attenuator to determine sound levels in each band . . . this instrument is particularly valuable for determining noise spectra of vehicles and machinery, for measuring sound-transmission losses of building walls, partitions, and floors, and for conducting speech-interference investigations.

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass., U. S. A.

NEW YORK AREA: Tel. N. Y. WOrth 4-2722, N. J. WHitney 3-3140 **CHICAGO:** Tel. VIllage 8-9400
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WE SELL DIRECT. Our District Sales Offices are staffed by engineers especially trained to help you in the selection of instruments and measuring systems best suited to your needs. We welcome your inquiries — will help solve your problems.

*Snap-Tite

QUICK-CONNECT

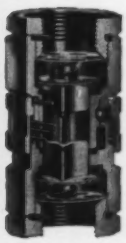
QUICK-DISCONNECT COUPLINGS

in larger sizes

immediate delivery

FROM FACTORY STOCKS

Snap-Tite's "H" Couplings are now factory-stocked for quick shipment to you, not only in the smaller sizes (below 1" ID) but in all sizes up to and including 3"—in steel, brass, aluminum, and 303 and 316 **Stainless Steel.** And "H" Couplings can be made to your order, up to 10" ID.



Available with valves to give two-way or one-way automatic line shut-off, or without valves for straight-thru flow, "H" Couplings are built to handle high pressures in hydraulic and air systems.

Recessed valve washers . . . fluted valve stems . . . valve stops with minimum flow restrictions . . . large inside diameter—allow maximum flow capacity with lowest pressure drop.

See the Snap-Tite representative in your city or write for Bulletin 240.

SNAP-TITE'S "H" COUPLING, SIZE FOR SIZE, IS THE SMALLEST COUPLING WITH HIGHEST STRENGTH AND HIGHER EFFICIENCY

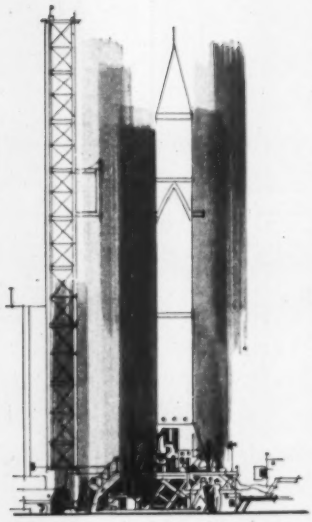
*Snap-Tite, INC.

UNION CITY 4, PENNSYLVANIA

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

Quality... from start to finish!

Versatile ACIPCO Centrifugally Spun Tubes



Look at that surface! Belt-polished to ±.0015″ tolerance and 25 microinch finish, this 20′ long, 26.25″ OD, Type 4130 steel tube was produced at ACIPCO for use as a hydraulic cylinder plunger. This application graphically demonstrates the completeness of ACIPCO's extensive Machine Shop facilities.

ACIPCO can turn and finish up to 60″ diameters and 41′ lengths . . . hone up to 29″ ID's and 16′ lengths. Turning, honing and other related machining equipment occupy more than 100,000 square feet of modern Machine Shop construction.

ACIPCO tubes are available to you "Custom Spun" in lengths up to 16′. . . diameters up to 50″. . . and thicknesses up to 4″. Welded assemblies can be supplied in any transportable length. ACIPCO produces standard and special analyses in steel and cast iron, including heat and corrosion resistant stainless steels. Tubes can be furnished as-cast, rough machined or finish machined, including honing.

Investigate the plus advantages of Acipco's "one-source — from start to finish" service. Write for full information or technical assistance.

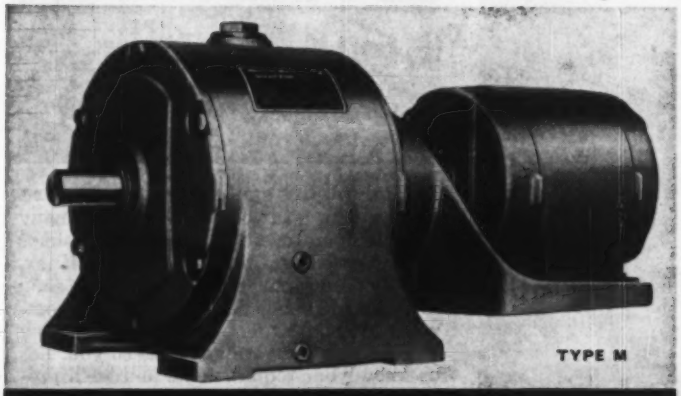
SPECIAL PRODUCTS DIVISION

AMERICAN CAST IRON PIPE CO.

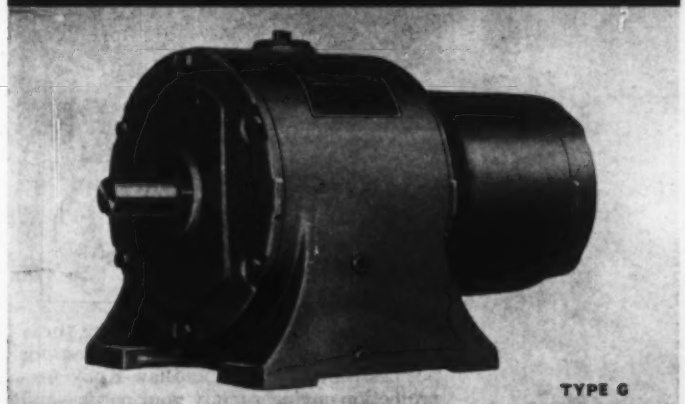
BIRMINGHAM 2, ALABAMA

MARKETING BULLETIN

Important Gearmotor Announcement



Customer-proved and -preferred advantages of this Western Gear all-motor gearmotor include: easy motor replacement; straddle-mounted high speed pinion for precision alignment; balanced heat treat to ensure long life; extra large inspection cap that eliminates removing end bells for inspection.



Utmost compactness is the first obvious advantage of the Western Gear integral gearmotor. Other superior points include: shank-type pinion that provides maximum strength and concentricity; precision-machined adapter that assures accurate alignment; double output shaft seal to keep oil in and foreign materials out; wide bearing spacing allowing maximum overhung loads.

Western Gear integral and all-motor gearmotors are companion products which may be converted, right in the field, simply by interchanging motor packages. Ratios changed easily and quickly, too, with no special tools. This unique advantage is of greatest importance when unforeseen requirements for different speeds or motor packages arise in the field.

Western Gear now marketing own line of gearmotors, products of 25 years of proved and preferred production for major motor manufacturers.

Western Gear Corporation announces the design, manufacture and marketing of its line of StraitLine integral and all-motor gearmotors ranging from 1 to 60 HP and from 9 to 520 RPM.

The StraitLine gearmotor combines all the best customer-preferred features proved through 25 years of manufacture for a major motor manufacturer.

Western Gear has designed its line of gearmotors utilizing the "building block" principle. This results in a minimum renewal parts inventory because of parts standardization, and in a high degree of interchangeability. Motor packages and gear sets are easily interchanged, and ratios changed simply and quickly, right in the field.

StraitLine gearmotors, both integral and all-motor, are available for immediate delivery in a wide variety of sizes and reductions, through Western Gear's district sales offices, representatives and distributors.

Glenn Malme • **Western Gear Corporation** ME
P. O. Box 182 • Lynwood, California

Please send me information on StraitLine Gearmotors.

name
title
company
address
city state

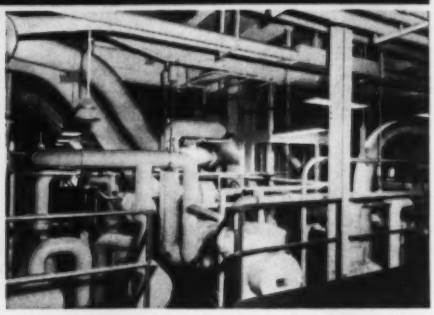
See your Western Gear Man in all principal cities about StraitLine gearmotors.

"The difference is reliability" • Since 1888

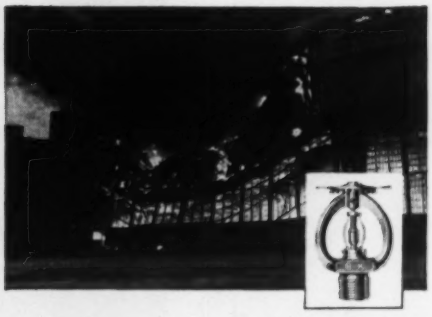
5803

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

BLAW-KNOX has what it takes—to provide these products and services



Heater piping system in this modern generating station is typical of many high temperature, high pressure systems prefabricated and erected by Blaw-Knox. Experienced piping engineers, modern shop facilities and a new Blaw-Knox digital computer method for fast, accurate calculation of piping stresses are available to you. Let us know your requirements and we'll provide the service you need. For more information, write for Bulletin No. 2443—"Piping for Industry."



Out of every 100 firms who lose their records in a fire, 43 never reopen for business. Be safe. Let a Blaw-Knox fire-protection engineer study your needs--and explain how you can pay for the system on our lease or deferred payment plan. To get more information send for Bulletin No. 2426—"Fire Can Destroy Your Business."

Blaw-Knox trapeze functional spring hanger installed in first large atomic generating station. Vital power piping system for the atomic generating unit in the Duquesne Light Company's Shippingport Station is supported by Blaw-Knox custom-engineered hangers.

Blaw-Knox makes a complete line of standard and custom-engineered pipe hangers, supports, and vibration eliminators. Each is a complete packaged unit, designed for a specific purpose and constructed to comply with the "code for pressure piping." Available in types and sizes to meet varying conditions, ready to install.

Blaw-Knox engineers, who have solved many difficult hanger and piping vibration problems, are always available to both design and make recommendations for your hanger requirements. For further information, write for Catalog No. 54.

BLAW-KNOX

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures ...complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators ...complete line of automatic sprinkler systems for standard and special hazards

WHY YOU SHOULD SPECIFY

Curtis

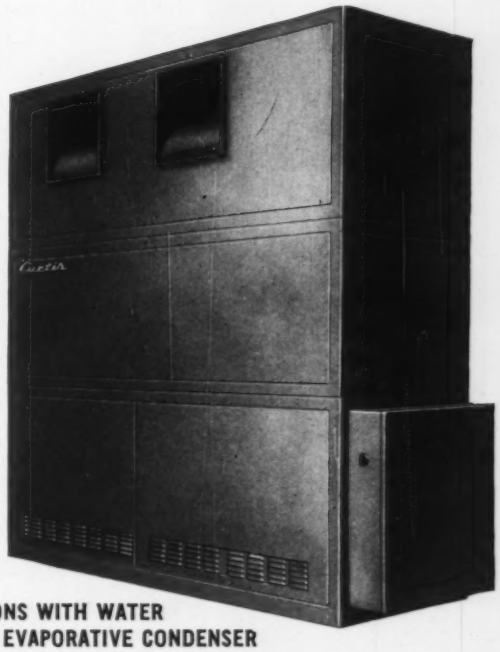
PACKAGED AIR CONDITIONING

INSTALLATION EASIER: Line assembled at the factory —eliminates expensive field labor.

PERFORMANCE KNOWN: Curtis units are run-in at the factory and guaranteed to deliver their rated tonnage. Assures a BALANCED SYSTEM.

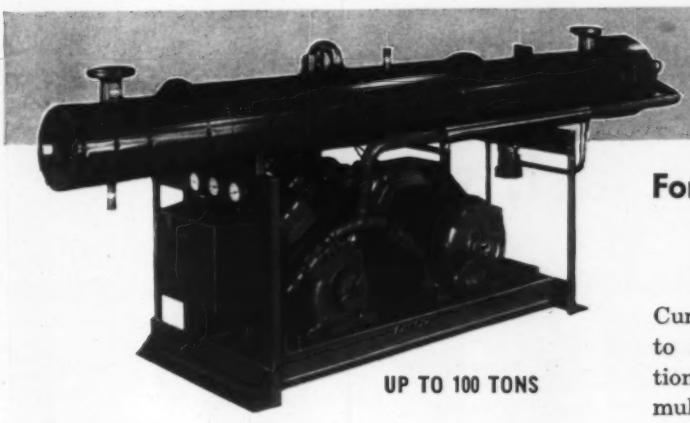
SUPERIOR EQUIPMENT: Long life, quiet, trouble free, economical operation.

DELIVERY ON TIME: Curtis can meet your delivery requirements, a decided advantage over multiple supplier delivery promises!



UP TO 50 TONS WITH WATER COOLED OR EVAPORATIVE CONDENSER

PACKAGED LIQUID CHILLERS



UP TO 100 TONS

For Air Conditioning Process Cooling Refrigeration

Curtis packaged liquid chiller lends itself to a widely diversified field of applications—air conditioning, refrigeration and a multitude of process cooling procedures. Available in capacities up to 100 tons.

REMEMBER, you can count on

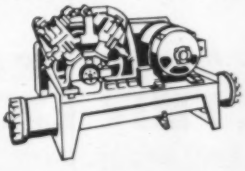
Curtis

OUR 104TH YEAR

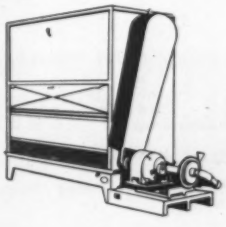
MANUFACTURING COMPANY • REFRIGERATION DIVISION

1940 Kienlen Ave., St. Louis 20, Mo.

Air Cooled Air Conditioning Units, 3-5-7½ tons. Residential and commercial application.



Condensing Units up to 100 tons.

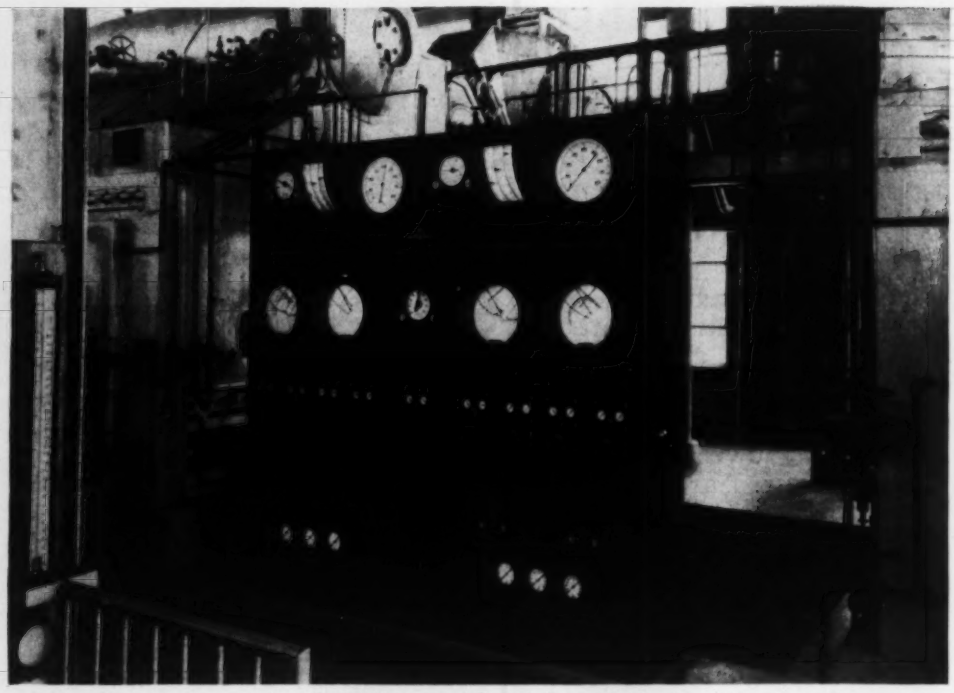


Cooling towers and evaporating condensers, air handling units to match.

ATTENTION ENGINEERS

For your complimentary copy of the *Curtis* Engineering Manual, write on your letterhead to: Chief Engineer, Curtis Mfg. Co., 1940 Kienlen Avenue, St. Louis 20, Mo.

C-33



Bailey Meters and Controls for two boilers in a midwestern milling company.

How Bailey helps you get a new boiler off to a fast, safe start——

--The thrill of putting a new boiler "on-the-line" can be marred if you lack adequate metering and control equipment. You are a lot surer of a fast, safe start and dependable operation for a long time when you specify Bailey Meters and Controls. They are keys to peak efficiency and low operating costs.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

1. A Complete Line of Equipment

You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A131-1

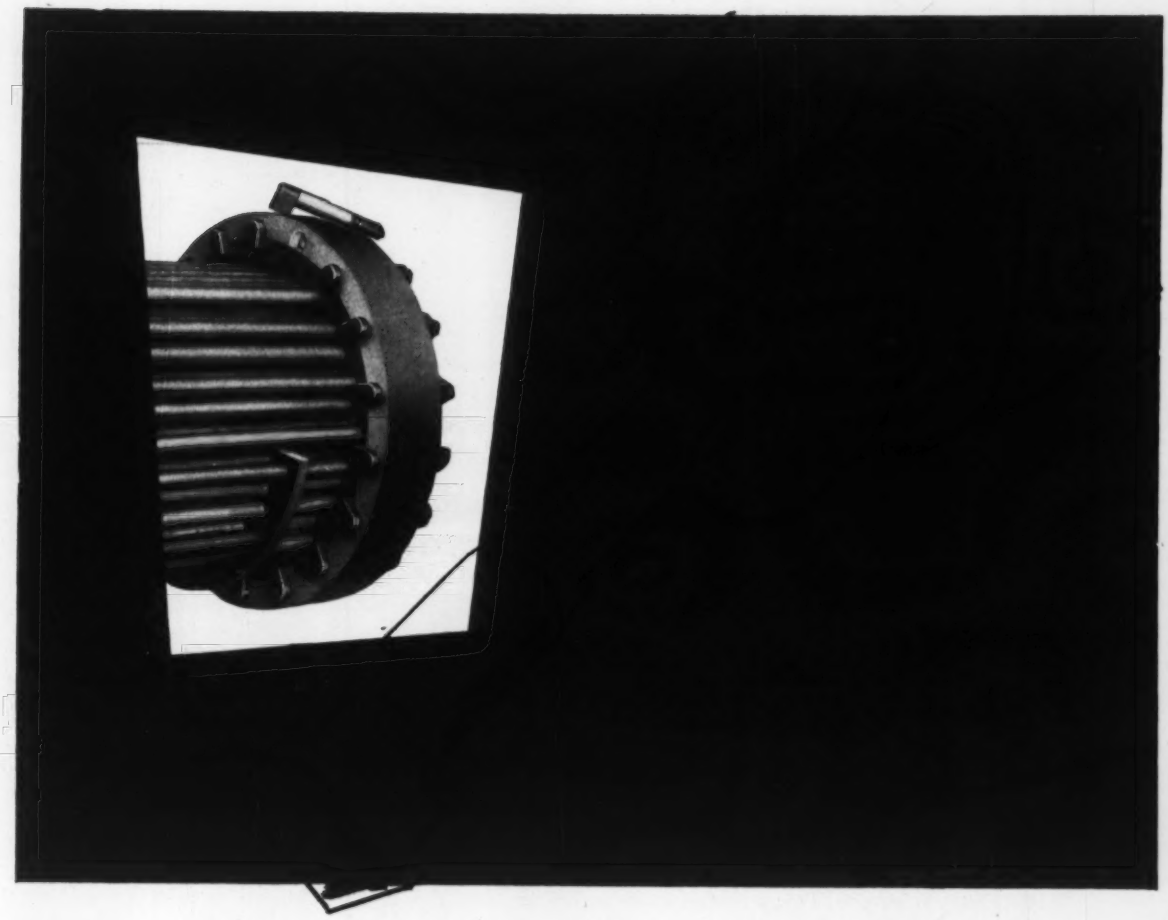
BAILEY METERS

Instruments and controls for power and process

BAILEY METER COMPANY

1026 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal



This Ell Bolt is the Key to leak control

The patented Ell Bolt construction employed on Vogt floating head heat exchangers is the answer to re-assembly without distortion or leak development.

Cover may be removed by simply loosening the Ell Bolt nuts and disengaging the Ell Bolt heads from the "lock notches." No misplacing of Ell Bolts can result — and tightening is easy and positive — absolutely leak proof. Send for Bulletin HE-6. Address Dept. 24A-XM.

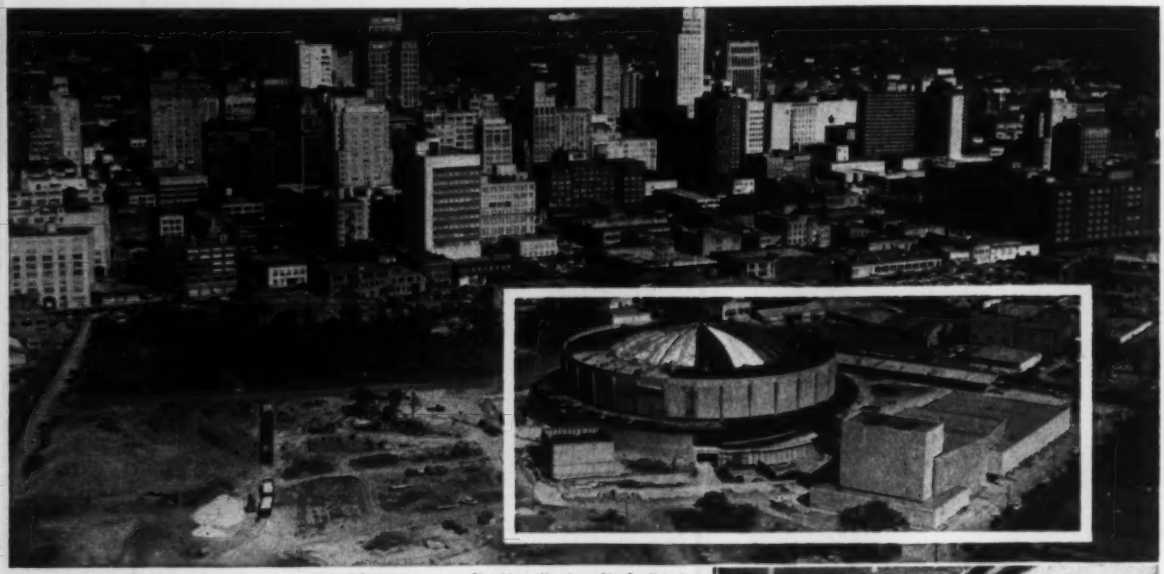
Vogt

HENRY VOGT MACHINE CO., P. O. BOX 1918, LOUISVILLE 1, KY.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati.

OTHER VOGT PRODUCTS
Drop Forged Steel Valves, Fittings and Flanges in a complete range of sizes • Petroleum Refinery and Chemical Plant Equipment • Steam Generators • Heat Exchangers • Ice Making and Refrigerating Equipment.

HEAT TRANSFER EQUIPMENT



Architect-Engineer
George L. Dahl Architects and Engineers
Dallas, Texas

General Contractor
R. P. Farnsworth & Co., Inc.
New Orleans, La.

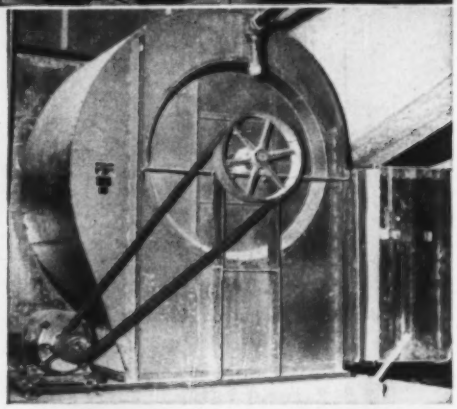
Plumbing, Heating, Air Conditioning
C. Wallace Plumbing Co., Inc.
Dallas, Texas

Another Coliseum Chooses Clarage Air Handling and Conditioning Equipment

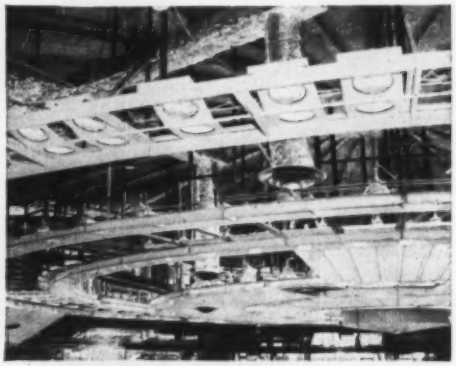
IMPRESSIVE in the Texas tradition is the new Dallas Memorial Auditorium. Its circular arena building, reportedly the largest cement domed structure in the nation, connects with a convention building and lyceum, shown on the right above.

Air handling throughout this vastness was assigned to Clarage equipment — Multitherm conditioning units, Unicoil sprayed coil units, giant system fans, ventilating sets.

Here again, as in New York's new Coliseum and other prominent buildings of all types, Clarage equipment was chosen for its recognized ability to perform quietly, economically, and dependably. CLARAGE FAN COMPANY, Kalamazoo, Mich.



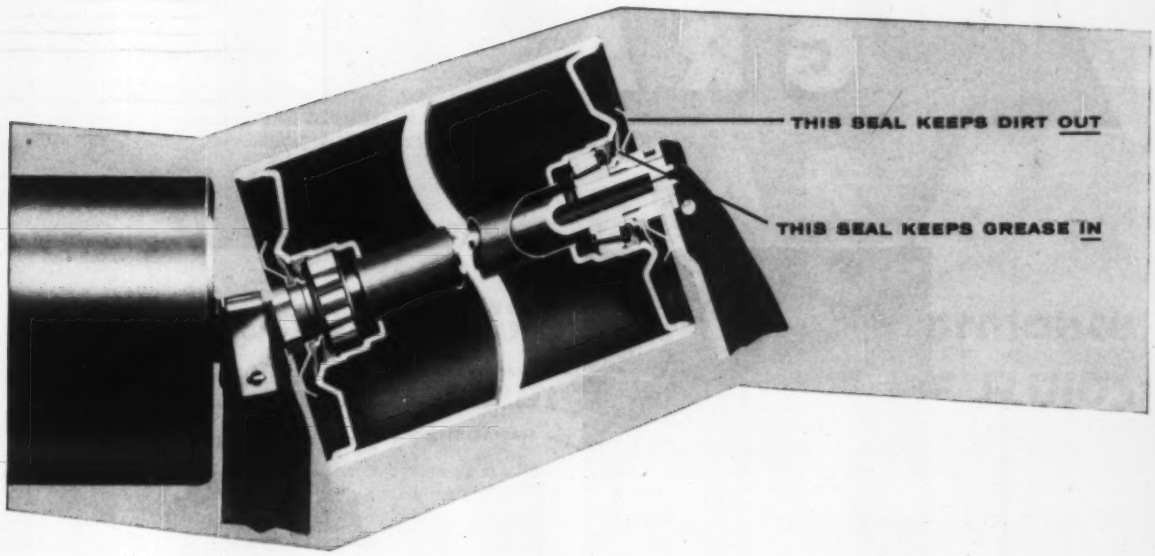
One of several Clarage Type NH fans located in the outer ring which encircles the Coliseum's dome.



Arrangement of air conditioning ductwork, viewed before completion of the ceiling.

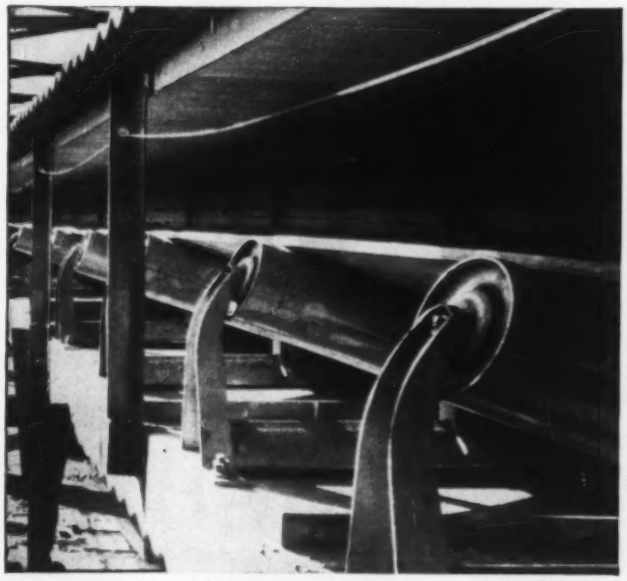
CLARAGE ... *dependable equipment for making air your servant*

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



JEFFREY PERMASEAL® IDLERS

The best built idlers for the toughest jobs



Belt conveyor equipped with Jeffrey PERMASEAL® Belt Idlers handling coal at a power generating station.

Grease can't get out to foul conveyor belts; dirt can't get in to damage bearings. Diaphragm double seals protect both ends of every roller. That's why Jeffrey Permaseal idlers give extra-long service with an absolute minimum of maintenance.

Greater dependability and longer life offset the slightly higher initial cost for Permaseal idlers. Pay off quickly on the tough jobs. Pay off, too, through less downtime, fewer replacements and lower upkeep on all belt conveyors.

Your materials-handling supervisor should have the new Catalog 909, Jeffrey Belt Conveyors. It has valuable design and descriptive data on these products. For a copy, write The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

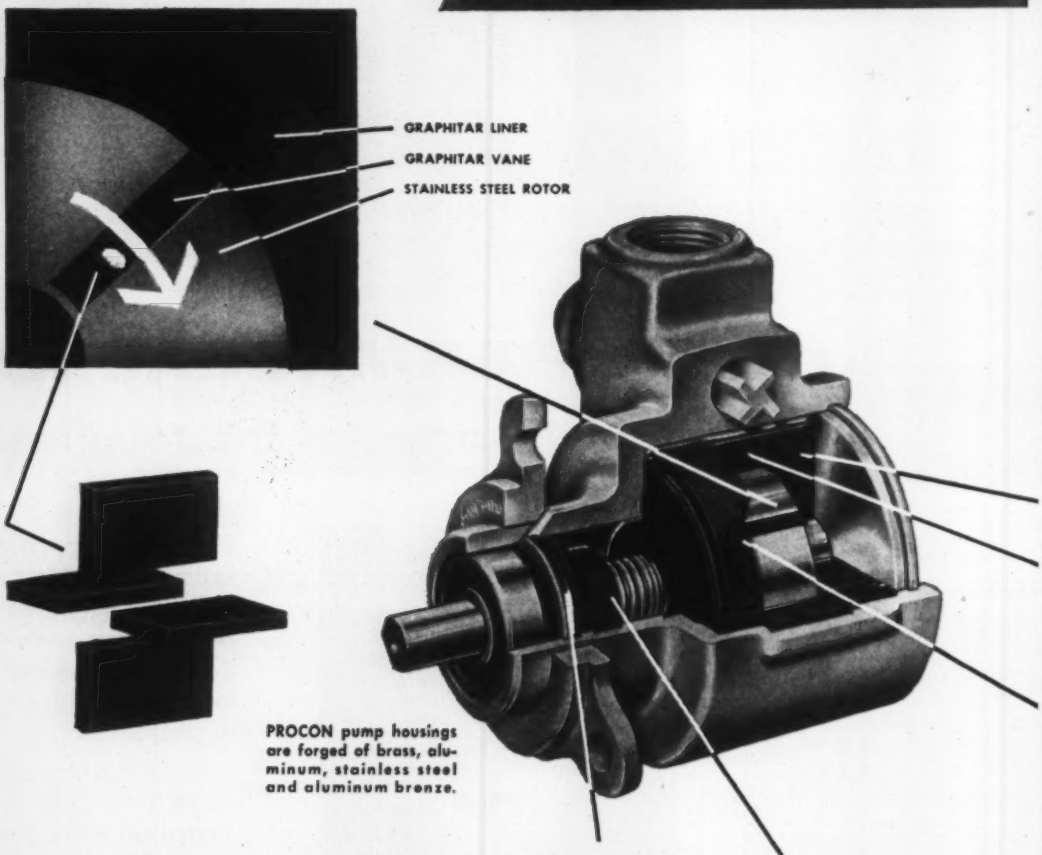
CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

JEFFREY

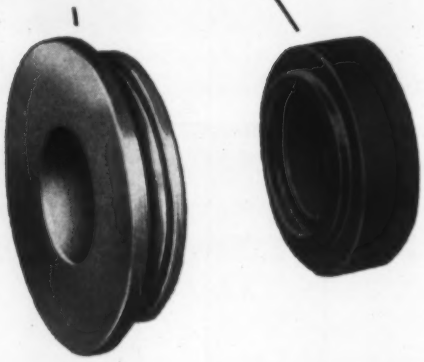
GRAPHITAR®

(CARBON-GRAPHITE)

against


GRAPHITAR LINER
GRAPHITAR VANE
STAINLESS STEEL ROTOR
PROCON pump housings are forged of brass, aluminum, stainless steel and aluminum bronze.
GRAMIX seal-ring retainer

GRAPHITAR is ideal for high-stress parts . . . pistons, cylinder liners, bearings and seals . . . because it's so resistant to temperature change and wear. Chemicals, concentrated acids, highly corrosive ammonia have little effect on GRAPHITAR . . . in fact, may even serve as lubricants to GRAPHITAR parts. GRAPHITAR is lightweight, can be produced economically in most any size and shape, and held to tolerances as close as .0005". Perhaps self-lubricating GRAPHITAR parts can improve the efficiency of your products. For more information on GRAPHITAR and its many applications, write for Engineering Bulletins No. 20 and 21.



THE UNITED STATES

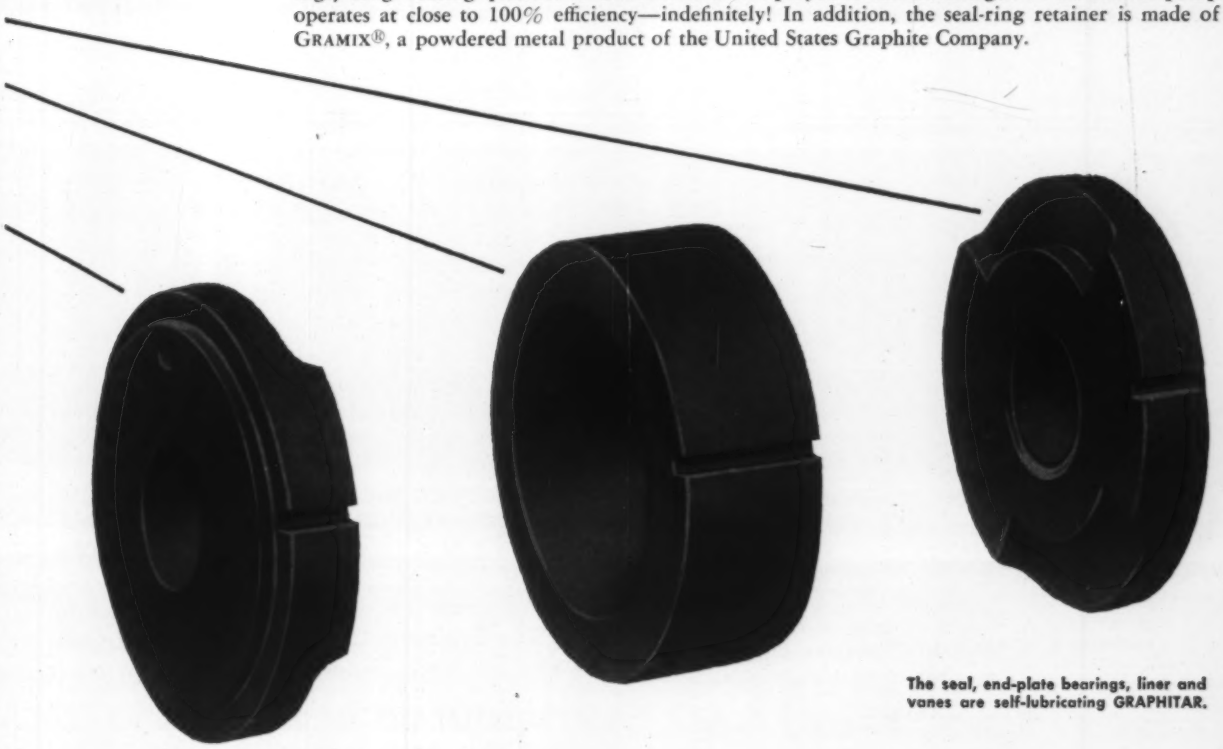
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

running GRAPHITAR®

gives PROCON PUMPS amazing performance in handling *ALL TYPES OF FLUIDS*

10¢ dropped in a beverage machine in Minneapolis actuates a pump that fills a paper cup with syrup and carbonated water; a Utah dentist flicks a switch that starts a vacuum pump used in molding dentures; in a manual training school in North Carolina, a pump circulates the ammonia in a blueprint machine.

Mixing soft drinks . . . pumping chemicals, ethyglycol, ammonia . . . even pumping hot fats at the rate of 275 gallons an hour at pressures up to 300 psi, is the every-day work of the dependable little Procon pump, manufactured by the Procon Pump and Engineering Company of Detroit, Michigan. The liner, vanes, end-plate bearings and the seal ring of this versatile, high performance pump are made of GRAPHITAR. The four GRAPHITAR rotor-vanes run directly against a GRAPHITAR liner. By running GRAPHITAR against GRAPHITAR the self-lapping, self-lubricating and astonishingly long-wearing qualities of GRAPHITAR are employed to full advantage . . . the Procon pump operates at close to 100% efficiency—indefinitely! In addition, the seal-ring retainer is made of GRAMIX®, a powdered metal product of the United States Graphite Company.



The seal, end-plate bearings, liner and vanes are self-lubricating GRAPHITAR.

R-256-2

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

CONSOTROL* RECORDING

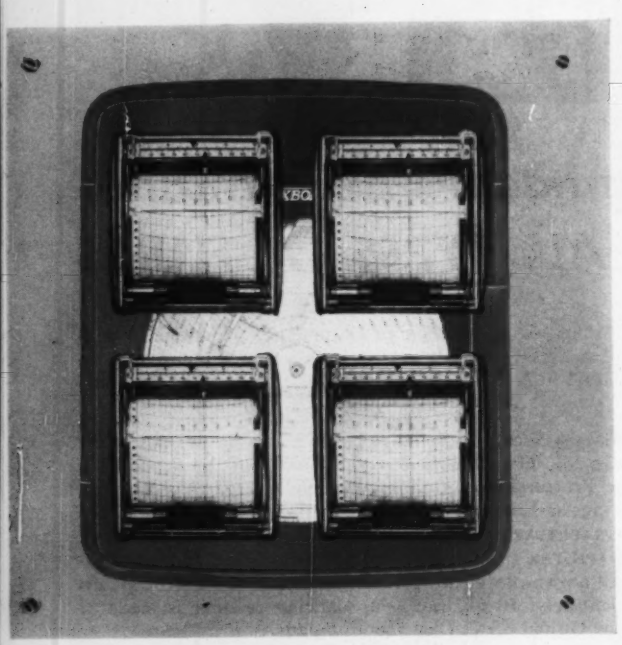


Illustration shows how 4 Consotrol Instruments require less panel space than does a single, conventional 12" recorder.

The ORIGINAL small-case control panel instrument with a FULL SCALE 4 INCH CHART...

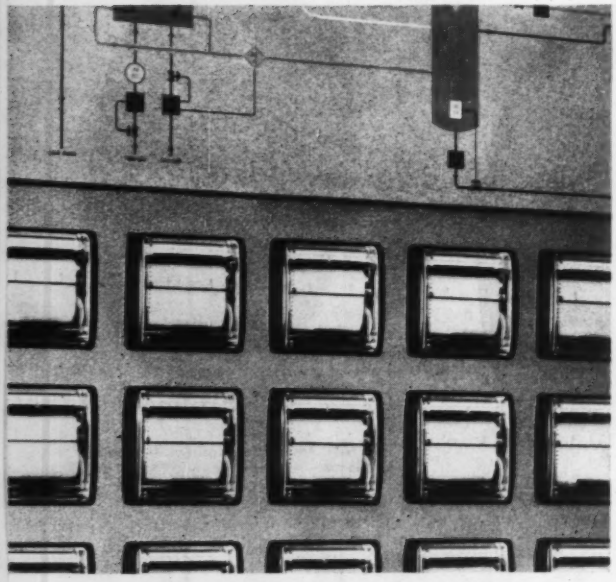
Full-scale *readability!* Here is the industry standard set by Consotrol Instruments, with no compromise in compactness, convenience, or performance.

These Recorders and Recording Control Stations are so compact you can actually mount 4 in the space required by 1 standard 12-inch recorder. And yet, inside the case, all components are full size — nothing is "miniature."

With the integrally mounted Model 58 Controller, the Foxboro Consotrol Recording Control Station provides precise, dependable control and full-scale chart records in one-quarter the panel space. Maintenance is easier too, with all calibration adjustments made from the front . . . re-inking needed only twice a year . . . chart changes as seldom as once a month.

For the complete story, write for Bulletin 13-18. **The Foxboro Company, 964 Neponset Avenue, Foxboro, Massachusetts, U.S.A.**

INTRODUCED IN 1952 — OVER 25,000 NOW IN USE



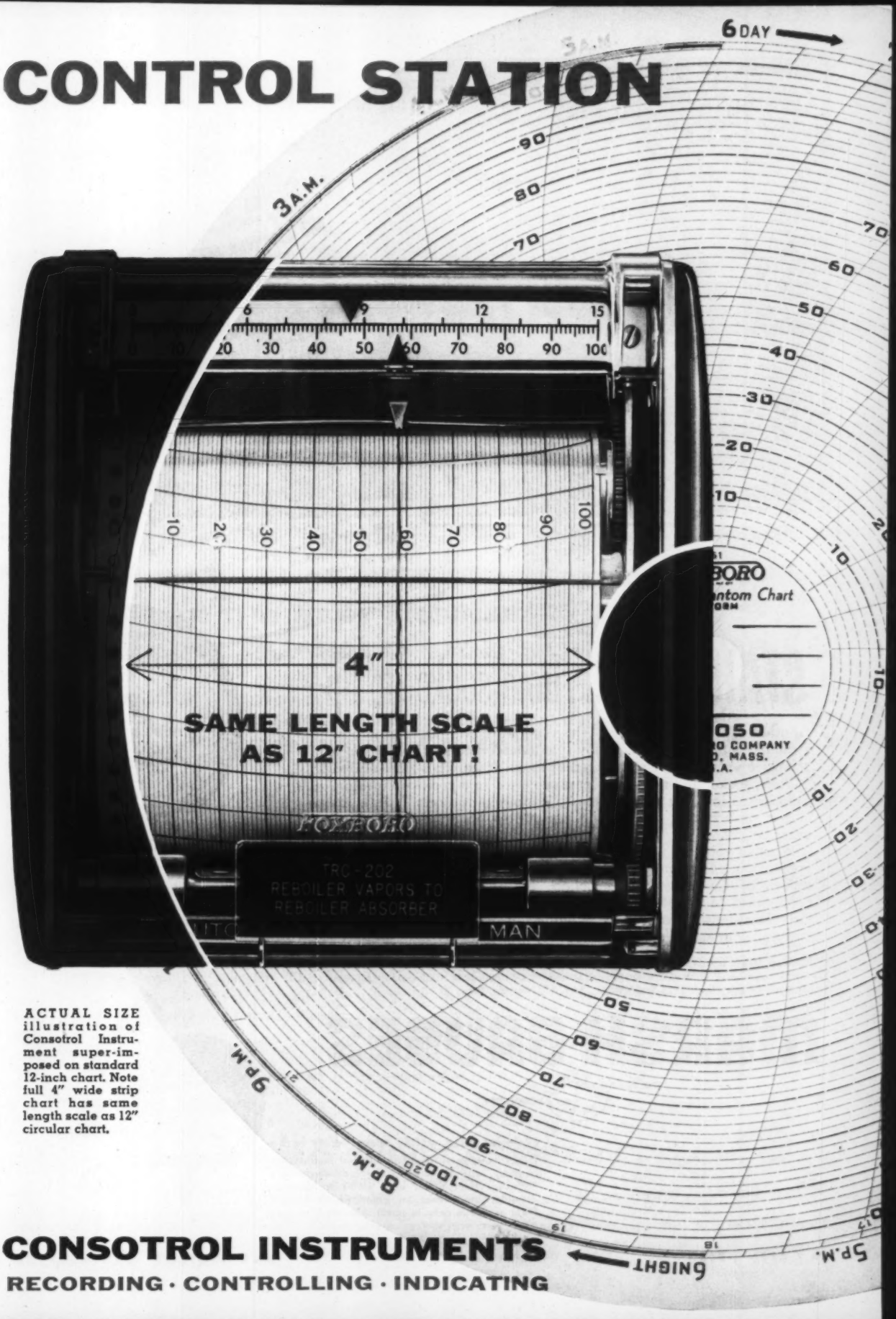
Typical control panel showing Consotrol Recording Control Stations. Associated M/58 Controllers, integrally mounted, pull out with the recorders.

*Reg. U.S. Pat. Off.

FOXBORO

REG. U.S PAT. OFF

CONTROL STATION



ACTUAL SIZE illustration of Consotrol Instrument super-imposed on standard 12-inch chart. Note full 4" wide strip chart has same length scale as 12" circular chart.

CONSOTROL INSTRUMENTS

RECORDING · CONTROLLING · INDICATING

Six choices of corrosion resistant tubes and sockets

4130 alloy steel tube with alloy steel tip and socket.

403 stainless steel tube with alloy steel tip and socket.

403 stainless steel tube with 416 stainless tip and socket.

316 stainless steel tube with alloy steel tip and socket.

316 stainless steel tube with 303 stainless tip and socket.

Monel tube with alloy steel tip and socket.

Tubes and sockets listed above are available in Type 100 Mastergauges which are designed for extreme service and pressures. Type 101 Mastergauges, for medium and high pressures, are available with:

4130 alloy steel tube, with alloy steel tip and socket.

403 stainless steel tube, with 416 stainless steel tip and socket.

403 stainless steel tube with alloy steel tip and socket.

STAINLESS...from socket to tip

Another Marsh development! The superlative Mastergauge is now available with stainless and alloy steel bourdon tubes. Try to find a corrosive service that isn't covered by range of materials listed above.

Tube, socket and tip—every part subjected to a corrosive medium —are fused into one piece by the "Connoweld" process . . . the exclusive process that distinguishes the Marsh Mastergauge from all other gauges.

Whether you need a gauge for corrosive service or any other critical application, Mastergauge is the one correct answer. It gives you the leak-proof Connoweld construction, the stronger, more durable copper-clad Marshalloy case, the precision Mastergauge movement, the "Recalibrator" to preserve its unmatched accuracy. Ask for data covering your specific gauge needs.

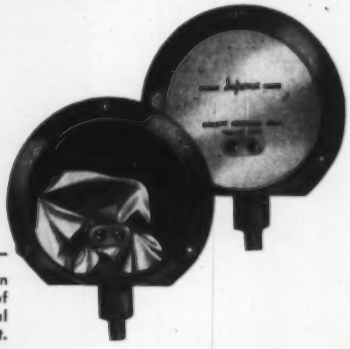
MARSH INSTRUMENT CO. Sales Affiliate of Jas. P. Marsh Corp. **Dept. 29, Skokie, Ill.**
Marsh Instrument & Valve Co. (Canada) Ltd. 8407 103rd St., Edmonton, Alberta
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

MARSH GAUGES

"THE STANDARD OF ACCURACY"

Stainless steel tube in the new SAFECASE

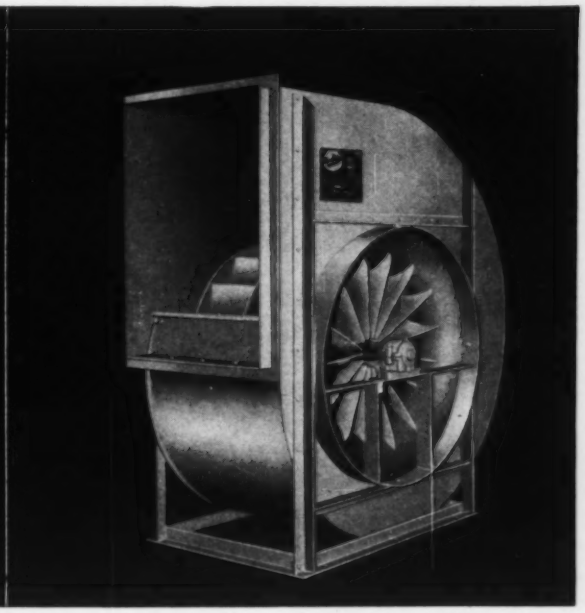
Here is a great combination . . . Marsh Mastergauge with corrosion resistant bourdon tube in the revolutionary Marsh Safecase . . . everything it takes for corrosive service where a surge of overpressure can occur.



Explosive force merely opens safety back—

Photo shows result of laboratory test in which gun cartridge was discharged in rear compartment of Safecase. Thin, tough back yields to abnormal pressure, but cannot be dislodged by blowout. Front of gauge remains intact, protected by heavy metal barrier.

For Classes III-IV (High Pressures) The "Buffalo" Type "BLH" Fan



For Classes I-II (Moderate Pressures) The "Buffalo" Type "BL" Fan

FOR THE BEST ENGINEERED JOBS, SPECIFY BUFFALO "JOB-SUITED" FANS

For central system applications you don't have to accept a "compromise fan", loosely designed to cover any and all pressure requirements. "Buffalo" builds *two* fans, each engineered to fulfill specific pressure requirements to the highest possible degree. Brief engineering details on these "no compromise" "Buffalo" Fans are given below.

The "Buffalo" Type "BLH" Fan is recognized by engineers and contractors alike for its outstanding performance in Classes III and IV service. The "BLH" maintains an extremely high mechanical efficiency of 86% over a broad operating range. The smooth inlet bell with matching shroud, directional inlet vanes, backward-curved blades and divergent outlet all contribute to quiet operation and minimum turbulence. "Buffalo" engineering features, plus husky construction, add up to an efficient high pressure fan that will deliver long, faithful, maintenance-free service. When you plan a conduit system or other Class III-IV installation, be sure to specify the "BLH". Call in your "Buffalo" representative or write for Bulletin F-200.

The "Buffalo" Type "BL" Fan has gained wide acceptance for peak performance in major Class I and II installations throughout the country. Non-overloading, the "BL" provides quiet, stable, output from free delivery to shutoff. The smoothly-curved inlet bell, with directional guide vanes and matching shroud, assures minimum turbulence. Highest efficiency is attained by the streamlined wheel with backward curved blades, factory tested and balanced to hold vibration to an absolute minimum. The correctly shaped scroll of the wheel-contoured housing further contributes to smooth air flow. For full information on the rugged, reliable "BL" Fan for Class I and II conditions, contact your "Buffalo" engineering representative. Or, write direct for Bulletin F-104.

You get a *value dividend* with the "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life in *every* "Buffalo" product.

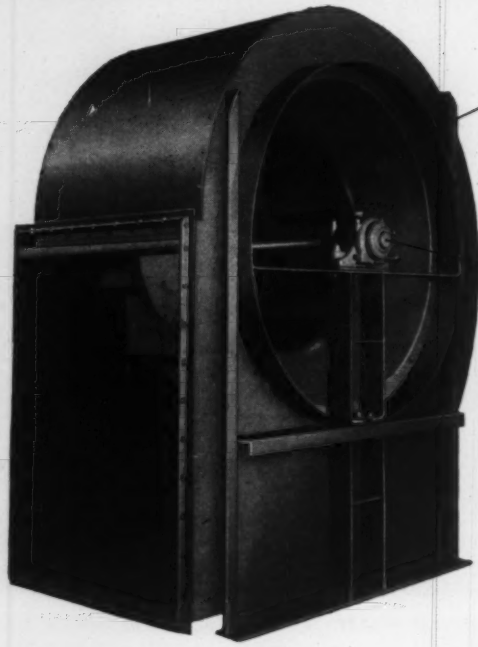
"Buffalo"

BUFFALO FORGE COMPANY • Buffalo, New York

Buffalo Pumps Division, Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



HIGH-EFFICIENCY STREAMLINE WHEEL

Large-area, backwardly inclined blades have true nonoverloading power characteristic. Medium-speed operation with minimum fan size is ideal for either direct connection to motor *or* V-belt drive.

CHOICE OF HEAVY-DUTY BEARINGS

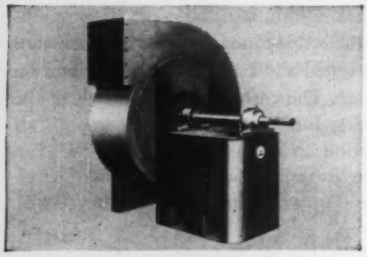
Standard – Heavy-duty, self-aligning ball-bearing pillow blocks.
Optional–Babbitted-sleeve, self-aligning type or roller pillow-block bearings.

American Blower HS Fans hit top efficiency at medium speeds with minimum fan size

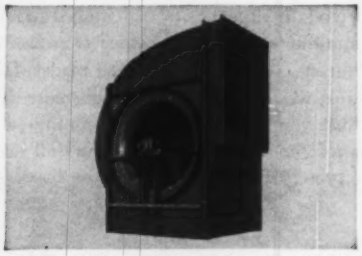
Versatile is the word for American Blower fans. For among this complete line of precision-built fans, you'll find an economical solution to *your* air-moving problem – whether it be ventilating, heating, drying or processing. And the heavy-duty construction of every American Blower fan guarantees you many years of low-cost, minimum-maintenance service.

Nationwide, 73 American Blower factory branch offices are ready to serve you. At your request, skilled sales engineers will help select the equipment to handle your air-moving job best within your budget. Call today! American-Standard, American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

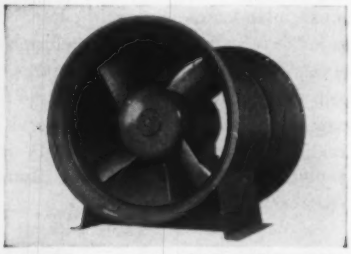
It pays to standardize on American Blower fans for every duty!



Industrial Fans – 3 optional wheels handle air, material, long shavings.



Sirocco Fans – low speed, quiet operation; move more air per revolution.



Axial Fans – move high volumes in minimum space; flexible installation.

AMERICAN-Standard
AMERICAN BLOWER DIVISION

Yes! . . . it's ALL STEEL

HP RANGE:
½ to 50 hp

RATIOS:
4:1—14:1—24:1 (or 20:1)

OUTPUT SPEED RANGE:
420 to 5 rpm

TORQUE RATINGS:
up to 31,500 lb-in

FALK
ALL STEEL
Shaft Mounted Drive

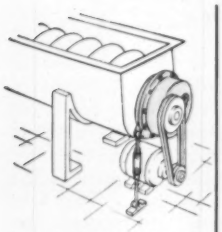
. . . Steel can "take it"!

STEEL frame . . . of fabricated plate supports all rotating elements—provides double the ability of iron to maintain vital alignment of revolving elements, even under shock load or external impact.

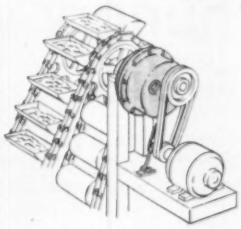
STEEL housing . . . will not fracture, serves only as protective cover and lubricant reservoir. Therefore, lubricant supply is safeguarded.

STEEL tie-rod and straddle-mounted tie rod brackets . . . are fastened to heavy steel frame by steel bolts in double shear.

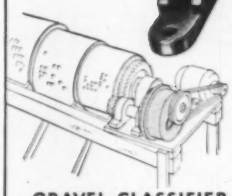
A FEW TYPICAL APPLICATIONS



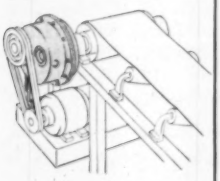
SCREW CONVEYOR



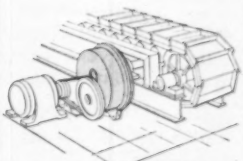
BUCKET ELEVATOR



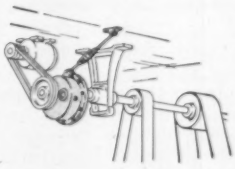
GRAVEL CLASSIFIER



BELT CONVEYOR



APRON FEEDER



LINE SHAFTING

DELIVERIES TO MEET YOUR REQUIREMENTS

Off-the-shelf delivery **from your Authorized Falk Distributor.** ***Shipment from factory or warehouse stocks*** **within 72 hours after receipt of your order.**

Write for Bulletin 7100

THE FALK CORPORATION, 3001 W. CANAL ST., MILWAUKEE 1, WIS.

Representatives and Distributors in Most Principal Cities

Manufacturers of Quality Gear Drives and Flexible Shaft Couplings

FALK

. . . a good name in industry

Bringing home the atom. Electricity will soon flow from the first full-scale nuclear power plant in America. This 235-ton reactor vessel was designed and built with alloy steels and nickel alloys by Combustion Engineering, Inc. It will supply power for the 60,000 kilowatt Shippingport plant designed by Westinghouse Electric Corporation.

In Shippingport atomic reactor...

Inconel "X" will keep "hungry water" on a starvation diet

"Hungry water" is the apt name for high-purity coolant that whirls through the super-hot core of a nuclear reactor.

It tries to feed on anything it touches!

Its immoderate appetite explains why the reactor for America's first full-scale commercial nuclear power plant had to be designed and constructed as it was—*with core mount springs made of Inconel "X"* age-hardenable nickel-chromium-iron alloy.*

Other spring materials would relax long before operating temperatures hit their peak above 500°F. Or they might fail completely from what is called "stress-corrosion cracking", or embrittlement. In either event, it would be impossible to make repairs because of radioactivity.

It was this consideration that practically dictated the choice of Inconel "X" alloy. An exceptionally tough spring material, Inconel "X" alloy stands up to heat . . . corrosion . . . stress. In a lifetime of use, it's not expected to give "hungry water" a morsel of encouragement!

Have you a metal problem? One involving corrosion, high or low temperatures, abrasion, fatigue? Some helpful answers are in our "Standard Alloys for Special Problems". Ask for a copy. If your problem involves springs, as this one did, ask us for *Technical Bulletin T-35.* Contains complete design information on Inco Nickel alloys for helical springs; it'll prove a valuable addition to your engineering reference files.

The International Nickel Company, Inc.
67 Wall Street INCO New York 5, N. Y.

*Registered trademark

INCO NICKEL ALLOYS

NICKEL ALLOYS PERFORM BETTER LONGER

MECHANICAL ENGINEERING

VOLUME 80 • NUMBER 4 • APRIL, 1958

More Engineers on the Way

With the United States preoccupied, as it currently is, with rockets, missiles, space travel, and atomics, and the definite need for engineers in these new technologies and, of course, in the more "down-to-earth" ones, it is gratifying to learn that engineering college enrollments for 1957 reached an all-time high. A survey made by the U. S. Office of Education in co-operation with the American Society for Engineering Education indicates that engineering enrollment in the U. S. and its outlying parts in institutions accredited by Engineers' Council for Professional Development totaled 257,777 students in the fall of 1957. This represents a 5.5 per cent rise over the previous peak of 244,390 students reported in 1947. The survey covers 152 ECPD-accredited colleges.

Of necessity, it is certain that many of these students upon graduation will find themselves on the threshold of exciting engineering adventures: the Sputnik-Explorer-space age with its exotic fuels, new materials, and complicated instrumentation; nuclear engineering and all of its ramifications; the advent of nuclear fusion; solar energy; automation; even wind and tide power—to name a few.

Here are some other points of interest from the ASEE report:

Engineering enrollment has shown yearly increases since 1951.

Total male engineering students in ECPD-accredited institutions made up 12.8 per cent of total male degree-credit enrollment in 1957, compared with 12.5 per cent a year earlier.

Enrollment of 67,071 freshmen in the fall of 1957 was up 1.0 per cent over 1956. All other classes of enrollment, except sophomores, also showed increases.

Part-time and evening undergraduate engineering enrollment in 1957 totaled 30,458 students—17.1 per cent above 1956.

Enrollment for the master's degree increased 7.6 per cent over the year before.

Some 4180 students were enrolled for the doctor's degree in 1957—a substantial increase of 22.9 per cent over 1956.

Evening student enrollment of 690 students for the doctor's degree in 1957 showed a marked increase—30.7 per cent over the year before.

During the 1956–1957 academic year, 27,748 first-level engineering degrees were awarded by ECPD-accredited institutions—a noteworthy 17.8 per cent increase over the previous year.

First-level degrees in engineering awarded during 1956–1957 constituted 8.0 per cent of the total first-level degrees (estimated). The 1955–1956 percentage was 7.6.

A total of 5203 master's degrees in engineering were granted by ECPD-accredited institutions—an 11.2 per cent increase over 1956.

Thus the supply of engineers has taken a definite upswing which should prove to be a reassuring factor in our race for technological supremacy. But by no means should we become complacent. The U. S. Office of Education indicates that there will be a continuing shortage averaging about 8000 per year for the next 10 years. It was estimated that some 70,000 engineers should be graduated each year by 1970—but even then the need will be greater than the demand.

It is necessary, therefore, that the utilization of engineering talent be greatly improved. Many of our engineers are presently (and probably will be in the future) employed in jobs below levels of their capabilities. Such flagrant wastage of valuable talent should be resolved so that the widening gap between the supply and demand of engineers ultimately will be bridged successfully.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.

Editor Emeritus, GEORGE A. STETSON

Human factors have a major effect on the efficiency of consideration operator attitudes, complexity the operator's reaction time. With the integration of

HUMAN-FACTORS ENGINEERING...

HUMAN-FACTORS engineering received its biggest impetus during World War II. As the weapons and machines of war became increasingly complex and more difficult to learn and use, fewer people were proficient at using them. Teams of psychologists and designers, assigned to the problem, achieved such results that postwar prime military contracts were revised to contain clauses requiring human-factors engineering to be considered for all military systems involving humans.

The value to industry of overcoming the friction between men and machines became evident. The benefits would include greater machine utilization and decreased absenteeism as well as increased good will and greater sales potential.

To be of most value, human-factors-engineering contributions to proper design concepts should be made at the planning stage, well in advance of any consideration of hardware.

An Industrial Application

A small human-factors activity was established at IBM's Airborne Computer Laboratory in the postwar period, and the group has expanded until it includes engineers, psychologists, statisticians, and other professionally and technically trained personnel.

The original group received many requests for evaluation of commercial products, and in 1953 recommended that a similar group be formed in our commercial development laboratory.

Meanwhile, the IBM Product Test Laboratory established a human-engineering activity, where commercial products are evaluated from functional as well as operating and maintenance points of view. Many of the test engineers are former customer engineers whose experience and contacts with customers and operators make them sensitive to man-machine relationships.

Unfortunately in the initial stages, testing-laboratory evaluations were "too late" in many cases. Changes were costly and difficult at the time of evaluation. To have human-factors problems recognized at an earlier design stage, a course in "human engineering" was established for department representatives most likely to influence the design of future machines. A university consultant who had often worked with the company was chosen as the instructor. His appreciation of past problems, as related to the products, was invaluable in shaping the course to the company's needs. There were three significant results:

1 The members of the class recommended to management that human-factors groups be established at the developmental laboratories. This reinforced the original proposal by the Military Products Human Factors Group.

2 The course left an awareness which was now explicit with the class members.

3 The testing laboratory personnel who took the course were better equipped to perform their evaluations and make recommendations for improving products.

Contributed by the Management and Machine Design Divisions and presented at a joint session with the Human Factors Society of America at the Annual Meeting, New York, N. Y., December 1–6, 1957, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 57—A-253.

As a result of these efforts, human-factors engineering is becoming a reality at IBM. An important step was the formation of a Human Factors Engineering Committee, with members appointed from all design groups and sales and planning areas. The group acts as a steering committee for members' problems, collects data for possible use in a handbook, disseminates information to interested persons, and promotes education.

Later, a human-factors group was established in the research laboratory to determine criteria for future evaluations in such broad areas as "memory retention in man" and "how man handles and stores information." Both the Committee and the laboratory group are available, on a consulting basis, to assist in planning experiments and evaluating the results.

In the product-development laboratory, human-factors specialists work directly with design engineers as part of the design team.

How the Activity Operates

At present the human-factors-engineering activity at Poughkeepsie, N. Y., is part of the Industrial Design Department. The contact the human being has with a machine is an important consideration in arriving at machine configurations.

A machine should not set up a psychological barrier to the operator when he is introduced to it or later when he works with it. His feelings in operating it, and the attitude of his fellow employees toward him because of his association with the machine are important considerations, particularly if he is looked down upon. Machines are also being made more appealing by the use of internal and external color and exposure of machine areas of interest.

Much of the human-factors engineering at Poughkeepsie is in the consulting field. The remainder is devoted to experimentation. The human-factors group includes an engineer trained in the principles of human engineering, in addition to an experimental psychologist. By working together they produce answers that are practical from both the engineering and human-engineering standpoints in a more effective way than they could if they worked in comparative isolation. The need for costly redesign is reduced, and human-factors considerations become organic to the development of the system.

To keep abreast of new developments in this field, membership in societies and committees working in the area is encouraged, and seminars are arranged at the

machine operation. Increasingly, machines are being designed to take into of operating procedures, and limitations on over-all efficiency when component speeds exceed these considerations into design procedures, practical and profitable results are obtained.

various plants. Consultants also work in the laboratories with the engineers and psychologists. There is representation on the ASME Committee on Human Factors in Engineering and with the American Psychological Association and other societies.

Typical Applications

A few representative examples of typical applications are as follows:

1 During the development of one machine, a choice of four combinations of card feeds and stackers had to be made. The possibilities were examined, and wooden mock ups of all four variations were constructed. Two possibilities were eliminated in preliminary analysis. In both, the operator had to perform more movements than in the remaining two, and fewer cards were processed in a given interval of time. One of the two remaining alternatives had a greater total operator idle time than the other. At first glance this was apparently a desirable condition, although closer study revealed that the intervals were of such short duration that they were virtually useless. The alternate arrangement which allowed fewer but longer and more useful idle periods was chosen even though the manufacturing cost was higher, since the "total" cost was less.

2 In the past decade "speed" has become a byword in the business-machine field. Computers, card-handling machines, and data-processing machines in general have grown faster and more efficient. Obviously, as machine speeds increase, unless card-handling procedures are mechanized and routings improved, we are bound to arrive at a point of diminishing returns. The operator will no longer be able to keep pace efficiently with the machine. Close observation of all our machine series by the human-factors group will warn us of any critical situations that are developing.

3 Adding more components without considering their relative value is one of the many pitfalls that can ruin a well-planned design. After a control station, console, or display has been designed, indiscriminate addition of more switches, lights, or meters can easily invalidate all of the previous planning. The operator may have to reach unnecessarily or look away from the planned center of attention. The human-factors engineer determines the over-all importance of the new additions and places them in correct perspective.

4 In co-operation with the industrial designer, machine components formerly covered are being "unveiled" in an effort to reduce monotony and boredom. Here the psychologist plays an important role.

5 The safety and simplicity of maintenance are other factors that are carefully explored in the planning stages.

These are but a few examples of the way in which the principles of human-factors engineering are being used.

Future Prospects

Some of the areas in which we hope to work in the future are the following:

1 A systematic schedule of points or stages in design planning at which human-factors considerations should be brought to bear.

2 Formulation of methods for identifying and describing the psychological implications of a given piece of equipment at any stage of its development or planning. These implications should be statable in terms of training time and effort, selection of personnel, motivations and incentives, speed and accuracy of performance, and flexibility in shifting of performance modes.

3 A classification scheme for predicting the nature of human error in perception, recall, decision making, and overt responses.

4 Special emphasis on the design of equipment for ease of maintenance, especially for input-output monitoring and fault location.

5 Improved procedures for computing the utility and reliability of systems that have human components.

6 Procedures for increasing the over-all flexibility and versatility of systems having human components.

7 Capitalization on what human beings like to do and can do as well as, or better and more cheaply than, machines. Human beings, for example, can cope better with novel circumstances and contingencies that demand some creative effort.

8 Development of methods for quickly simulating a proposed work situation to get experimental data, or to rapidly try out new arrangements of components as they affect operators and maintenance personnel.

..A Working Program!

By A. H. Schroeder

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Considerable progress remains to be made in these areas, and we can anticipate considerable gains. We expect to maintain close liaison between the applied and research laboratories without putting restrictions on either activity. We recognize the need for continuously expanding and sharing knowledge and skills among our various specialists. To this end, reference material and handbooks will be compiled that can be used by both human-factors people and design engineers. This effort in itself should reveal gaps in knowledge and capability that need to be filled in by further study and research.

It is impractical to train all engineers to be human-factors specialists. It is highly practical, however, to give them a set of attitudes and interests favorable to recognizing the human component not only as a nuisance and liability but as a potential asset in system performance. It is also important for the engineer to have some idea of the questions he should be asking of himself and the human-factors specialist. We may then be able to say that we are inventing systems for human beings.

AVIATION'S

Pictured here are a few of the aircraft that played—and are playing—significant roles in aviation's golden age.

1 McDonnell F-101 which, though lighter than the B-17 of World War II, can carry a greater bomb load farther. But payload and range often go unnoticed as speed becomes the first criterion. Speed, which has multiplied 40 times since the first planes, also is the source of most of the technical difficulties that must be surmounted.

2 The P-38, probably the first plane fast enough to encounter such control problems as "shock stalls" and "tuck under." The 1940–1945 era saw huge production but only hurried solutions to the new aerodynamic problems.

3 The P-80, first of the operational U. S. jets. In the first jet era, 1945–1950, power-boosted controls came in and the swept-back wing began to appear. The mysterious forces of the sound barrier loomed in aviation's path.

4 and 5 McDonnell F3H, and the North American F-100, examples of aircraft developed in the transonic era of 1950–1955. Today, military aviation has moved into the supersonic stage, with fighters and bombers both designed to exceed the speed of sound.

NOT WITHSTANDING the scientific excitement one feels over the earth satellites, it is still the solid achievements in aircraft which have the most effect upon us all personally.

Since it is customary to use speed as the measuring stick of aeronautical progress, and since advancing speeds have been the real source of most aeronautical problems, aviation's golden era—1940–1960—may be organized about speed as the central theme. This is called the golden era because, in just a few short years, man pushed aeronautical frontiers back from 450 mph to well over 2000 mph—a truly astounding progress. The golden era can be organized around the level flight speeds of the fastest military aircraft.

		Mach No.
1940–1945:	Mature reciprocating period	up to 0.7
1945–1950:	First turbojet period	0.7 to 0.95
1950–1955:	Transonic period	0.95 to 1.4
1955–1960:	Supersonic period	above 1.4

Mature Reciprocating Period

During the 1940–1945 period, the painful progress made in reciprocating aircraft engines since the Wright brothers was distilled into a few wartime designs built in huge numbers. Refinements included multirow engines, cooling fans, ejector exhaust stacks, and high compression ratios, all aimed at squeezing out the last bit of engine performance.

The airplanes of this period were characterized by straight wings 15 to 18 per cent thick, retractable landing gears, and manual controls operated entirely by the pilot's muscles. Fighter weight was of the order of 12,000–15,000 lb and bombers of 60,000–80,000 lb. These airplanes behaved very well up to speeds of about seven tenths the speed of sound, where alarming controllability problems asserted themselves. The P-38 was probably the first aircraft to have sufficient performance to really be bothered by these controllability problems.

One typical problem was "tuck-under," where separated flow behind shock stalls on the thick wings changed the angle and velocity of flow over the horizontal tail so that the tail no longer provided enough force to hold up the nose (Fig. 6, *top*), and a progressively steeper and often fatal dive resulted. Another was shock stalls on one wing, causing that wing mysteriously to lose lift and roll the airplane. The flow patterns were such that normal use of the ailerons only accentuated the roll.

Hurried test programs developed fixes for each trouble of each aircraft, but it wasn't until the next cycle of airplanes that design techniques achieved essentially restriction-free operation. This period was noteworthy for setting few significant records except production.

First Turbojet Period

The postwar years were the years of firsts in modern American aviation. Just before the war ended, the P-59 became the first U. S.-built experimental jet airplane.

GOLDEN AGE

From a builder of jet aircraft comes this evaluation of the fabulous period from 1940 to 1960, a report intended for observers rather than participants

By J. E. Forry[1]

McDonnell Aircraft Corporation, St. Louis, Missouri

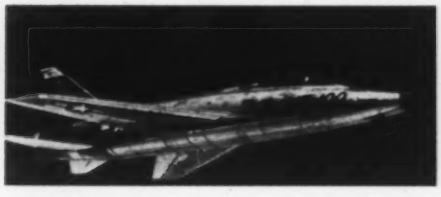
Soon after, the P-80 became the first operational U. S. jet. McDonnell designed and produced for service use the first U. S. twin-engined jet and the first carrier-based jet in the world, the Navy FH airplane, which made the first take-off by a jet airplane from an aircraft carrier.

The typical airplane of the first part of this period had a straight wing with 11–15 per cent thickness. It had power-boosted controls and was powered by nonafterburning turbojet engines. Toward the end of the period, aerodynamic lessons learned from the Germans were applied, and the swept-back wing made its appearance.

Some of the characteristics to be corrected during this period were: buffeting, pitching-moment changes, and aileron buzz. There were problems of engine-inlet design and, after swept-back wings were introduced, pitch-up, aileron ineffectiveness, low elevator effectiveness, and low maximum lift coefficient.

Consider pitch-up. One factor is the distribution of lift along the wing. The behavior of an airplane in pitch (about its thwartship axis) in a straight-wing airplane is controlled basically by the pitching-moment characteristics of the wing plus the action of the horizontal tail. On the other hand, in a swept-wing machine some of the lift-producing wing area is forward and some aft of the center of gravity. Hence if the amount of lift contributed by the tips should change in relative magnitude, major variations occur in the tendency for the wing to pitch up or down. Other phenomena result in lift of the wing tip becoming substantially less as the angle of attack is increased beyond some critical value (Fig. 6, *center*), causing the airplane to nose up more and more unless controls are used to oppose the action.

The avoidance of pitch-up involves the compromise of other desirable features. Thus one finds aircraft designed to avoid pitch-up and accept costly weight, drag, and other penalties; and at another extreme one finds aircraft designed to accept some correctable pitch-up but offering advantages in efficiency.



What characterized this period? First, it was a period of digestion of the turbojet engine. Here was a prime mover with a new behavior pattern which had a profound effect on airplane design. Second, it was a period of sampling, of exploration of a dangerously unknown regime of flight in which unseen and sometimes unanticipated forces shook, rattled, and roared at airplanes. Men lost their lives, but the sampling and digestion process continued in preparation for the assault on speeds above that of sound.

Transonic Period

These years saw the sound barrier, as it was romantically called, reduced from an unscalable mountain to an occasionally difficult foothill.

Basically, two accomplishments permitted the building of transonic aircraft. The first was the development of efficient and reliable afterburners, for without this device for multiplying turbojet high-speed thrust extended flight in the transonic speed regime would still be impossible. The second accomplishment was the adaptation of machine-shop production techniques to large aeronautical components, thus making possible the production of efficient thin airfoils with desirably low drag.

There were, of course, a large number of related important developments in power controls, materials, and components such as tires and brakes, which contributed to the efficiency of transonic aircraft such as the McDonnell F3H and the North American F-100.

The problems of pitch-up, control-surface ineffectiveness, and low induction-system efficiency, all continued into this higher-speed region. And an interesting new problem arose. This has been known as pitch coupling,

[1] Manager, Product Applications.

Contributed by the Aviation Division and presented at the Joint Aviation Conference, Dallas, Texas, March 17–20, 1958, of The American Society of Mechanical Engineers and the American Rocket Society. ASME Paper No. 58—AV-5.

or lateral-directional coupling. Airplane shapes have been in a state of transition from long-wing-short-body to short-wing-long-body with an accompanying change in weight distribution, as illustrated by the barbells (Fig. 6 *bottom*). When subsonic airplanes are made to roll in flight, centrifugal force acting on the larger barbell tends to maintain its axis normal to the flight path. However, in the case of the supersonic airplane, if the airplane is made to roll about its flight path while at an appreciable angle in pitch or yaw, centrifugal forces acting on the barbell will tend to rotate the airplane to bring its axis into a position normal to the flight path—and airplanes don't fly well sidewise. The onset of this problem created a stir three years ago, but the design features to avoid it are now well established, and avoiding it seems to present no great difficulties.

Supersonic Period

This period includes the introduction into service of truly supersonic fighters and the initial production of a supersonic-bomber design. Generally speaking, none of these airplanes are as technically adventurous as those of the earlier generations. On the other hand, only skillful design makes possible the range, payload, and high speed shown by this group.

This period of 1955–1960 is almost certain to be looked upon as a time of refinement and consolidation of knowledge—a period in which new information was being gathered for the assault on the "thermal thicket," but mainly a time when service aircraft showed attention to detail rather than impressive explorations of new flight regimes.

Research

The progress which has taken place is the result of an intensive and extensive research program. The joint military-NACA series of research vehicles starting with the X-1 and D558-I have carried men and instruments into new and unexplored regions. Wind tunnels have provided the data for these designs. The pace setter of progress is well-managed research.

Civil Aviation and Jet Flight

The Airlines. In any review of aviation progress, those elements which are in the vanguard receive the most attention. Military aviation, setting the speed records, dominates the scene. But it is civil aviation which brings a better standard of living to large groups of people, and no review would be complete without marking some of its achievements. The airlines will soon offer $4^1/_2$ to 5-hr schedules coast to coast and at a cost comparable to that of today's 8-hr schedules. Back of these new jets lies a history of progress in airline operating techniques and improved machines offered by the aircraft manufacturers. The product offered—speed—has been climbing up to the present 350 mph, and soon will jump to over 550 mph.

Private Flying. Transportation of business men by corporation-owned aircraft soon can be speeded by small jet executive transports if government purchases are sufficient to make prices reasonable. The number of corporations owning aircraft has been increasing at a rate of 10 to 15 per year during the past decade, and from 1946 to 1954 the number of miles flown annually in business aviation increased from 122 million to 564 million, a growth of more than 350 per cent. Ranging from small single-engine machines to airliners, the airplanes offer economy and speed in everyday business. Introduction of jets to this field will help managers of sprawling interests, or corporations with dispersed customers, operate their business with a snap and dispatch impossible today.

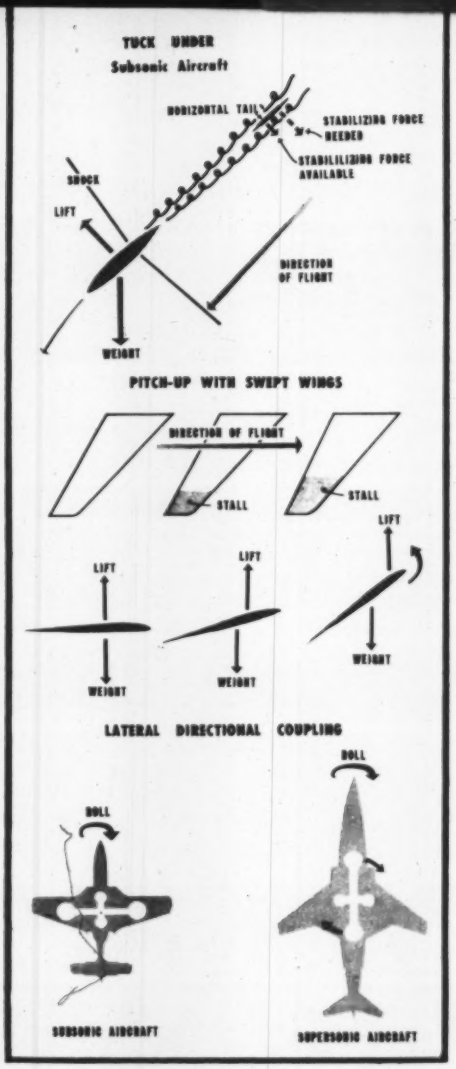


Fig. 6 With speeds near and beyond the supersonic, unforeseen forces appeared, presenting problems in flight control. Three are diagrammed here.

The Greater Struggle

Those actively engaged in aviation may not agree completely as to the significant advances, the landmark aircraft, or the list of troublesome problems. However, the lesson which can be drawn from this review was stated by Walt Whitman, "...from any fruition of success... shall come forth something to make a greater struggle necessary." Out of the jet engine grew the afterburner. Out of the combination grew the transonic and supersonic airplane. Now the "greater struggle" is to penetrate the thermal thicket and make even speedier and more efficient aircraft.

PLASTICS ENGINEERING 1956-1957

A Review of DEVELOPMENTS

By E. E. McSweeney and R. G. Heiligmann

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The past year has witnessed a strong growth pattern in plastics engineering, one not confined to any particular area but spread across the broad spectrum of raw materials, fabrication, and applications. Notable improvements were made in proprietary materials and several newcomers arrived on the scene. To these material developments may be added a novel approach for controlling the composition range of copolymers. A new technique gives promise of producing copolymers of predictable and homogeneous composition.

Limited commercial application of radiation to plastics was also noted during this period. Increasing emphasis was placed on further refinements in processing and fabrication techniques to meet the new demands. One notable outcome has been the increasing use of plastics in large-scale industrial applications.

Finally, and of major importance, this period has witnessed an accelerated development of excellent and highly useful engineering data. This accomplishment, long overdue, has stemmed from the fact that plastics are finding more and more applications as materials of construction and, in numerous instances, have penetrated into fields once served exclusively by ferrous and nonferrous metals, glass, wood, and rubber.

The over-all plastics sales record has shown gains since 1954 of almost 50 per cent in poundage and 45 per cent in dollar volume (1).[1] The production of synthetic resins and cellulosics in 1956 was just under 4 billion pounds, representing a limited increase over the 1955 volume. Sales approximated 3.7 billion pounds in 1956, averaging 33 cents a pound, compared to 3.2 billion pounds in 1955, averaging 34 cents a pound. As this is written, it appears that production will top 4 billion pounds in 1957 and that sales should approximate 4 billion pounds, averaging perhaps 32 cents a pound.

In the past, emphasis has been placed on making plastics resemble other materials of construction such as wood, leather, and woven fabrics. It is the consensus that plastics should take advantage of the fact that they are unique and sell themselves on their own merits (2).

This period has witnessed the entry into this field of large companies seeking to diversify their interests (3). Petroleum companies are vigorously exploiting their raw materials and getting into the plastics business. Rubber companies are making use of their polymer know-how and are moving into the field. There has been some acquiring of fabricators by plastics producers. Thus one major plastics producer acquired a major film fabricator. Current antitrust activity will influence such trends.

There are some divergencies of opinion with respect to the growth pattern. While this period has again witnessed marked growth and expansion, there are those who believe that the growth rate is slowing, with competition among products and between companies making the same items. Others believe that the greatest growth period is still ahead. This period has seen much research and development, including market development.

FOREIGN DEVELOPMENTS

Italy, France, and Germany have made notable strides in plastics production; and Germany, as might be expected, continues to set the pace in volume, variety, and sales (4). Essentially all of the basic plastics are now being produced in Europe. Germany has led the field in high density polyethylene development, and has contributed considerably to a new class of plastics—the polycarbonates. Italy has brought polypropylene to the production stage and is continuing to make major contributions to the development of highly ordered polymers via heterogeneous catalysis.

Great Britain has continued to "come out of its shell" with respect to consumer attitude toward plastics. Polyvinyl chloride, polyethylene, and polystyrene remain the "big three" of the thermoplastics in Great Britain, although cellulose acetate has been cutting into polystyrene. Sales of thermosets are also increasing.

Each country has problems dictated by geographical location: Factors such as availability of raw materials, skilled labor, and equipment and the attitudes of the people play a dominant role. This is especially true in the Near and Far Eastern countries. On the other hand, U.S. know-how and capital invested in such countries as Australia and Japan have continued to produce increased dividends in the plastics field.

MATERIALS

It is significant that practically all the new materials are thermoplastic but at the same time possess sufficiently high softening points to resist boiling water or even higher temperatures.

Polyformaldehyde. Low molecular weight, unstable polymers of formaldehyde are well known. However, it was not until early in 1956 that the first hint came, in a U.S. patent, that useful polymers of formaldehyde, per se, could be made. Late in the year du Pont confirmed this with a conservative announcement of "Delrin," which is being produced only in pilot-plant quantities (5). Its high strength, resistance to deformation under moderate loads at 100 C, low moisture absorption, and potential low cost, suggest a bright future. It holds promise in

[1] Numbers in parentheses designate References at end of paper.

Based on a paper contributed by the Rubber and Plastics Division and presented at the Annual Meeting, New York, N. Y., Dec. 1-6, 1957, of The American Society of Mechanical Engineers.

injection molding of gears, bearings, and other precision parts, and as extruded pipe and wire coatings. In many of these uses it will be competitive with nylon.

Polycarbonates. Discovery of an interesting new group of polymers was announced during the year by three companies, each of whom apparently had been working independently (6, 7, 8). Farbenfabriken Bayer made the first announcement in September, followed in the spring by General Electric and Eastman. These polymers are characterized by high strength, excellent heat resistance, dimensional stability even at temperatures approaching 300 F, and good electrical properties. Both fiber and film possibilities are said to be promising. Bayer offered the first commercial electrical insulation foil.

Polyethylene. Polyethylene was, as usual, the most discussed material (9, 10). Tangible progress was made; at least four low-pressure plants came on stream and a high-density, high-pressure product was offered for the first time. At this writing, the new materials have not been on the market long enough to allow careful appraisal of their individual merits and their respective places in the industry. In fact, the number and variety of materials which will soon be available are already leading to confusion. Suggestions about possible generic names have been made, but no completely satisfactory solution to this problem seems to be in sight.

At least two Phillips-process plants (Phillips and Celanese) (11) were on stream by June, and one Ziegler (12) plant was completed but awaiting raw material. Allied Chemical also announced they were in limited commercial production, presumably using a process of their own. Several other producers of Phillips and Ziegler materials were nearing commercial production, while at least two other processes were being studied. Spencer (13) and ICI (14) announced the availability of "high-"density material made by the high-pressure routes.

General opinion is that the high and low-density materials will each find their own markets and not be intensely competitive. The high-density material will dominate where properties such as high softening point and greater stiffness are especially useful; for example, in housewares. On the other hand, opinions vary greatly on the future place of the two materials in pipe. Greater flexibility, with related ease of handling, favors the low-density product, as does its lower price. But the high-density material can be used in thinner sections and has better resistance to hot water. Tendency to stress cracking was cited as an early fault, but Farbwerke Hoechst (15), the first commercial producer, apparently overcame this by a special formulation. Allied (16) indicate that their new material is outstanding and they are channeling all their initial production into the pipe market.

Increasing competition was foreshadowed by a 10 per cent price reduction of low-density polyethylene; also, at least two companies are reconsidering the desirability of entering the market.

Availability of high-density film with superior heat resistance did not deter General Electric (17) from increasing their annual capacity for irradiated film to 1.6 million pounds. Some details were given (18, 19) regarding the importance of additives in both the General Electric and Sequoia-Grace irradiation processes.

Polypropylene. The position of this polyolefin is still speculative (20, 21). Isotactic polypropylene (Moplen) is being produced in Italy by Montecatini. This company is said to be also considering production in the U. S. While most reports have stressed fibers as the initial product from this polyolefin, it is reasonable to assume that other fabrication approaches, including molding and vacuum forming, are receiving attention. On the domestic front, most polyethylene producers are known to be considering polypropylene.

Chlorinated Polyethers. Both Hercules and Imperial Chemicals Industries, Ltd. (22, 23) have this pentaerythritol-derived plastic under development. Some details of the Hercules product were disclosed at the ASME Annual Meeting in November, 1956. The material has a highly crystalline structure and is characterized by good electrical properties, low heat distortion, and excellent dimensional stability. Many mechanical and electrical applications are being considered where its relatively high cost, compared to polyolefins, will not be a deterrent.

Urethanes. Interest in these versatile products heightened considerably, principal emphasis remaining on coatings and foams (24, 25). Some of the disadvantages resulting from the toxicity of the critical isocyanate component were overcome by development of prepolymers, and promise of lower costs was seen in Wyandotte's announcement of polyether components.

Silicones. Although these remain relatively high-priced products (26), production has grown steadily until it is now said to approach 30 million pounds. Chief development, last year, was the organo-functional silicone compounds (27), latest of which is a silicone-substituted methylmethacrylate (28). Such materials can be used to modify other plastics and should greatly increase the uses of silicones. Another new and potentially large use was also announced (29)—a silicone interlayer for aircraft safety glass.

Fluorocarbons. One of the early producers of these materials, Kellogg, bowed out of the field by selling out to Minnesota Mining. In addition to du Pont, Minnesota Mining, and Carbide, Allied is readying fluorocarbon resin. Du Pont announced an easier-processing Teflon which will not be available for another year or two (30).

Epoxies. Announcement (31) of commercial production of glass-reinforced epoxy pipe should give these resins a new boost, as should expanding use in tooling. Improved high-temperature-resistant epoxy-phenolic adhesives were also announced (32).

Polyesters. The polyester boom, so long predicted, seems to be really here. Increased use in structural applications seems to be the primary reason. New material developments included a superior weather-resistant resin.

Nylon. Two new producers (Spencer and Foster-Grant) have caprolactam-based nylon-6 plants under construction. This expanded production will be channeled to the growing fields of molding and extrusion (33).

Styrene Polymers and Copolymers. The trend toward high-softening-point materials was seen, too. Cyanamid's plant for methylstyrene resins started production in March. Improved copolymers also have been developed. Such products should help styrene considerably in future competition with high-density polyethylene (34, 35).

Vinyls. At least one more new major producer was added, and the trend toward complete integration continued with the construction of several relatively small plants by consumers of PVC products (36).

NEW PRODUCTS

Advances in fabricating techniques, including the adaptation of the principles of automation to high-speed mass production, have been outstanding. Such advancements have permitted plastics to make notable gains as materials of construction. Outlets such as luggage and footwear showed notable gains in plastics consumption. The transportation industry, including cars, trucks, railroads, and airplanes made major strides in furthering the application of plastics, both as engineering and decorative materials. Housewares, building construction, refrigeration, lighting, packaging, and agriculture also made major contributions in increasing the versatility of application of plastics. New and improved products also found their way into the industry.

To explore the versatility of plastics, a major chemical company undertook the construction of a research laboratory utilizing eighty different applications of plastics. It is essentially all plastic outside and almost all plastic inside, thus showing what can be done within the framework of conventional building practices. This same company also built a house showing the freedom of design made possible by plastics. The value of building products derived from plastics in 1956 has been estimated at approximately $500 million, or about 15 per cent of the total product of the plastics industry.

Plastic Pipe. Thermoplastic pipe, as an engineering material of construction, continued to grow at a rapid pace (37, 38, 39, 40). While this end item is not new to the chemical processing industry, substantial progress has been made in adapting it to potable water supply systems, irrigation projects, and to the petroleum field as a crude oil carrier. Among the thermoplastics, polyethylene still retains a healthy lead in sales volume. This period has witnessed considerable progress with respect to a better definition of the performance characteristics of thermoplastic pipe in terms of properties and extrusion characteristics. Long-range performance data are also becoming available.

Thermosetting plastic pipe, i.e., glass-reinforced polyester and epoxy, has had a long, hard road. Considerably more complex in fabrication than the thermoplastic variety, it has suffered numerous reverses in the effort to reach an essentially "foolproof" stage. Recently, one of the major pioneers has claimed that epoxy-glass reinforced pipe has "come of age," i.e., it will perform satisfactorily at 1000 psi and temperatures up to 220 F (41).

Glass-Reinforced Products. In addition to the pipe field, other advances were made in glass-reinforced products during this period. Most notable was the continued advance in the fabrication of large parts (42). New combinations of materials, new molding methods, and innovations in designs have largely contributed to this growth. Bathtubs, garage doors, boats, and automobile bodies have shown themselves to be realistic growth areas for reinforced plastics. Other areas showing promise include aircraft fuel tanks, toilet bowls, school desks, chemical laboratory and plant equipment, packaging and heating equipment.

Foamed Plastics. Advances in production and application of plastic foams centered around the "big three"—vinyl, polyurethane, and styrene (43). One source predicts a sales volume for polyurethane and vinyl foams of 150 million pounds each by 1960. Many current and projected outlets may be mentioned, including packaging, automotive and upholstery cushioning, sportswear, sponges, toys, thermal and sound insulation, industrial filters, and gaskets. In addition, this period has witnessed further application of foams in sandwich structures. With the rapid expansion of this section of the plastics industry, additional attention has been given to the development of test methods and standards.

The polyurethane foam picture may well have gotten a pleasant "shot in the arm" via the introduction of polyethers as an intermediate (44, 45). Lower prices for the polyethers make the industry's prospects brighter than ever. This period has also witnessed the introduction of inexpensive, dependable foam-making equipment. It is now claimed that polyurethane foam can be produced more cheaply than foam rubber.

Of recent vintage are the polyethylene foams. Foamed polyethylene retains all of the basic desirable properties of the parent material, i.e., moisture resistance, toughness, flexibility, and chemical resistance. It can be drilled, sawed, hot gas welded, and friction and heat sealed. Potential applications include gaskets, cap and closure linings, buoys, and radiation shielding. Another new challenger, the thermoset polyester foams, may prove competitive to rigid polystyrene foams in structural insulating applications. Current application targets including refrigeration and transportation.

Plastic Films and Containers. The packaging field continued to represent the major outlet for films and containers fabricated from a variety of plastics (46, 47, 48). Thin-walled throw-away containers from low-cost styrene put in their appearance during this period. Mylar film and modifications of the same continued to expand in the packaging field. Of interest are boilable film bags for frozen foods, i.e., "heat and eat." These bags are made from laminated or extruded polyethylene on Mylar. The trend to transparent containers has also involved films of cellulose acetate, polyethylene (high-density films can withstand temperatures up to 240 F), Saran, and the vinyls. There is a recent trend toward utilizing polyethylene film in greenhouse construction.

Irradiated Plastics. This period has witnessed much basic and some developmental work in the application of radiation to plastics (49). Radiation has shown itself to be a promising tool in effecting changes in basic polymer structure through grafting and crosslinking; the unfavorable economic aspects will continue to limit extensive commercial applications for some time to come.

Adhesives. The increasing application of plastics as materials of construction has, of course, put considerable pressure on the development of improved adhesives (50). This period witnessed further developments of such common workhorses as polyvinyl acetate, urea formaldehyde, and epoxies. Metal bonding adhesives likewise received increasing attention. In particular, a phenolic-epoxy combination was developed which purportedly was resistant to 200 hours' aging at 550 F. Other basic studies were notable during this period, including those dealing with shear strength of metal-bonding adhesives, pot life, and the selection of adhesives and bonding methods for the cementing of plastics.

PROCESSING and EQUIPMENT

Trends in processing and equipment during this period were toward greater productivity, lower unit costs, and more uniform quality. Of considerable note was the progress toward automation in almost all branches of plastics processing. Coupled with this were definite

trends toward larger molded parts made possible by improvements in processing and equipment. Techniques in injection molding, thermoset molding, laminating, extrusion, sheet forming, and calendering were the subjects of studies and improvements during this period (51).

With respect to *injection molding*, more attention was given to mold design and fabrication in an effort to provide realistic quotes on plastic parts. The results of a significant study appeared, relating the influence of flow orientation and injection temperature on the strength of injection moldings.

The field of *thermoset molding (compression and transfer)* was noticeably affected by the trend toward further automation. Mold design permitting completely automatic compression molding of coil forms was introduced. Automatic feeders adjusted to load multiple cavities, and completely automatic transfer pressures also made their appearance.

In the *laminating field*, a new technique was introduced. The uncured resin, moderately conductive, serves as its own resistance heater. Electrodes, in contact with the laminate and insulated from the platens, effect the cure. Progress was made in extending the long-time heat resistance of phenolic laminates with improved techniques.

In *extrusion*, the theory and practice of screw extrusion was enhanced by recent studies of the feed section. Equations have been derived for delivery rates in that section. Only the melting, or transition, zone remains to be studied. A method was introduced permitting crosshead dies to be designed to make uniform film. This should help in alleviating the severe sheet extrusion problem of obtaining uniformity of caliper over the entire width of the sheet.

The extrusion of polyethylene was also given a detailed treatment. Employing established extrusion theory, the results portray the behavior of polyethylene in the extrusion process.

The trend toward automation was felt in *sheet forming* during this period. Heating, drape and vacuum forming, and cooling can all be done automatically. Gains are thus made in uniformity of product and in savings in capital investment, space, and labor. Another recent development makes possible the forming of deeper, stronger parts than can be made by simple vacuum or drape and vacuum forming.

In *calendering*, a new tool for control of caliper was introduced. In addition, a method was developed to calculate roll separating forces which provides a sound basis for design of rolls, shafts, and bearings of calenders.

STANDARDS and EDUCATION

The plastics technical committee of the International Standardization Organization proceeded with the drafting of international standard procedures for testing plastics (52). Various ASTM committees were noticeably active in drawing up and adapting new tentative standards. In addition, important revisions were made in specifications for various plastic materials and new definitions were added to the list of terms relating to plastics. Finally, drafts of three recommended Commercial Standards were circulated for acceptance by industry.

Realizing the need for developing effective screening methods for new plastic materials, the Air Force undertook the development of a guide manual known as a "Polymer Evaluation Handbook." This will be used in conjunction with the extensive polymer synthesis research program being sponsored by the Air Force. It is hoped that this approach, the first of its kind, will be further expanded and modified as new techniques and tools are developed in order to provide an effective procedure for rapid screening of experimental materials.

Industrial, institutional, Government, and academic groups are working to define more closely the physical behavior of plastics. This has accounted in part for the increasing acceptance of plastics as engineering materials. This past year has witnessed an increasing interest in the establishment of a national plastics institute designed to provide research and development facilities for the industry. Germany, Holland, and France possess organizations of this type.

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CASTINGS

Process Controls **Magnetic Design Characteristics**
Nondestructive Testing **A 225,000-psi Steel**

Process Controls for Making Turbine Castings[1]

THE twofold problem of supplying steel with improved strength in high quality castings has challenged the foundry industry to carefully examine each of the many links in the chain which exist between the raw material and final casting.

Improvement of Properties

Much has been learned over the years concerning the effect elements have, singularly and in combination, in steel for turbine application. As temperatures and stresses increased, molybdenum was first added to previously used carbon steels and vanadium was later added to increase strength as temperatures increased while chromium eliminated graphitization. Present 1050 F operation in turbines is achieved by an alloy incorporating all these elements and others to increase hardenability. The General Electric and similar ASTM alloy specifications are compared in Table 1.

The differences in alloying-element ranges are minor. However, the differences in carbon, phosphorus, and sulfur are important and worthy of brief discussion.

Carbon. When the carbon is much below 0.15 per cent, hardenability of the steel is lowered with the possibility of ferrite greatly increased. Ferrite reduces stress rupture and creep strength.

Phosphorus. At phosphorus levels of about 0.040 per cent, temper embrittlement increases appreciably. Impact transition temperatures of aged samples are raised about 122 F as phosphorus increases from 0.01 to 0.05 per cent.

Sulfur. In many instances sulfur will greatly aggravate hot tearing in castings. If improper deoxidation is employed, serious reductions in room-temperature ductility result. Special furnace practice is employed to assure minimum sulfur levels (0.009 per cent average).

Minimum hardenability is specified in order to minimize the formation of ferrite. If all elements were at the low side of the range, the DI would be 7.5. Thirty to 40 per cent primary ferrite in bainite can reduce rupture strengths up to 50 per cent. Obviously, the highest hardenability which will produce a ferrite-free structure without resulting in temper embrittlement or inadequate rupture ductility is justified.

Fig. 1, a plot of the 100,000-hr (1060 F) rupture stress versus controlling factors shows the predictability of rupture strength under certain measurable conditions. The rupture strength is improved by (*a*) increasing vanadium levels, (*b*) higher yield-strength tensile-strength ratio (measure of ferrite), and (*c*) higher tensile strength, while increasing carbon sacrifices rupture strength.[2]

As the vanadium level increases in silicon-deoxidized material, the rupture ductility decreases. If carbon is

[1] From the paper by Robert Ahles, manager, Product Engineering, Schenectady Foundries, General Electric Company, Schenectady, N. Y.

Based on five papers contributed by the Metals Engineering Division and presented at the Fall Meeting, Hartford, Conn., September 22–25, 1957, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] The data and information presented are from tests and records of the Turbine Division of the General Electric Company. Effect of chemistry and heat-treatment on stress rupture strength was obtained from high-temperature tests conducted by the Large Steam Turbine Generator Department. Chemical and room-temperature data were compiled from records of the Schenectady Foundry of the General Electric Foundry Department.

Table 1 Comparison of General Electric and Similar ASTM Alloy Specifications

	ASTM A356-52T C9	GE B50A154-B
C	0.20 max	0.15/0.20
Si	0.60 max	0.30/0.50
Mn	0.50/0.80	0.60/0.80
P	0.05	0.030 max
S	0.050 max	0.030 max
Cu	...	0.35 max
Ni	...	0.50 max
Cr	1.00/1.50	0.85/1.15
Mo	0.90/1.20	0.90/1.20
V	0.15/0.25	0.15/0.25
Al	...	0.01 max
TS	95 000 psi, min	95 000 psi, min
YS, 0.02 per cent	60 000 psi, min	60 000 psi, min
Per cent elongation	15 min	15 min
Per cent reduction	35 min	45 min
Ferrite hardenability, DI, min		12.0

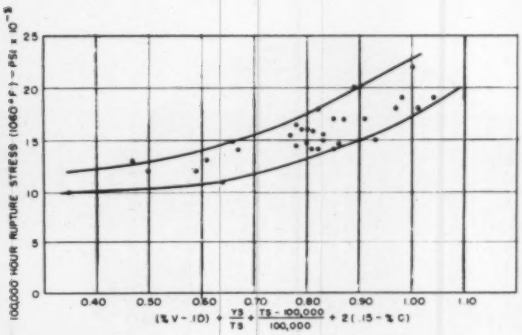


Fig. 1 The effect of chemistry and room-temperature mechanical properties on stress-rupture strength

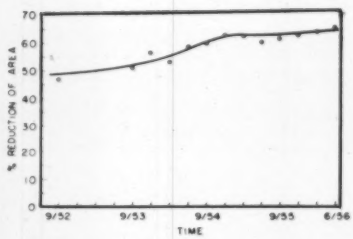


Fig. 2 Change in per cent reduction of area, 1952 to 1956

abnormally low, quantities of ferrite may occur and seriously reduce strength. Both of these very clearly demonstrate the need for close control to obtain the proper balance or combination of properties.

Because this balance in properties is necessary, there are optimum zones of chemistry within the specification range. As added knowledge of gains to be realized by even moderate chemical changes is achieved, the aim points are adjusted for new levels. A comparison of the mean and standard deviation of the heats of B50A154-B in 1953 and 1956 are presented in Table 2.

The mean of all purposely added alloying agents except carbon has increased. In most cases the control of elements is much better in 1956 (the bottoms of the ranges were raised with little change in the top). Probably of equal importance, as far as room-temperature properties and casting quality are concerned, is the drastic reduction made in the tramp elements, phosphorus and sulfur achieved through melting-practice changes made early in 1954. These furnace-practice changes also insured a low nitrogen level in the steel. It is not unusual to have nitrogens of 0.007 per cent, while seldom do they exceed 0.010 per cent. This lower nitrogen results in coarser grain sizes, better hardenability and less ferrite. Recent changes have caused a decrease in hydrogen in the steel from around 4 to 4.5 ppm to about 2.5 to 3.5 ppm, and have eliminated hydrogen levels above 4.5 ppm. This will insure that hydrogen flaking will be at a minimum, and will improve tensile ductility.

As the microstructure and properties are controlled as much by heat-treatment as chemistry, appreciable attention has been given to means to assure the proper bainite structure in the casting as well as the test bar. Castings vary in size from 100 to 40,000 lb, and in section from 1 to 20 in. Four to six thermocouples are placed on the load during each heat-treatment. Close attention is given to the manner of loading and the total weight of each load. Extensive use of fans and ducts is made to accelerate the cooling from the austenitizing temperature.

The effect of these changes and increased controls is shown in Fig. 2, which is a plot of the tensile ductility of this 1% Cr-1% Mo-¼% V alloy (100,000 average tensile strength) from mid-1952 to mid-1956. The reduction in area has improved from slightly under 50 per cent to 63 per cent. During 1955 the specification reduction of area was changed from 35 to 45 per cent minimum. No heat has failed to meet this requirement in two years.

The over-all result of the improved foundry processing and control is that turbine components are being produced in steel of aircraft quality. This is only as it should be considering the critical functions these castings perform.

Because of the greater uniformity, the width of the scatterband of creep and rupture properties was appreciably reduced. The bottom side of the band was raised enough so that the allowable stresses could be raised 10 to 20 per cent at the higher temperatures.

Improvement in Quality of Castings

The upgrading of the metal property is only half the job challenging the foundry. The properties obtained in the ideally shaped coupon must be representative of the alloy and structure of the more complex and sometimes appreciably greater sections of the castings. The casting should also be as defect-free as possible because of the lower high-temperature properties of weld metal.

The progress of the Schenectady Steel Foundry in reducing defect volumes in turbine shells and valves by 60 per cent in two years is shown in Fig. 3. This was the direct result of the application of new materials and processes, additional process control, and engineering-design knowledge. A system of maintaining detailed foundry-processing records of individual castings was installed, which permitted correlation of foundry practices and defect volumes.

Generally defects were found to fall in one of five major categories: Shrink, hot tears, cracks, gas, or sand. With the improved materials and methods available, each type of defect has been worked on toward final elimination. The problems and methods of correction are complex.

Shrink. It is of extreme importance that the sections of castings be designed and constructed to insure directional solidification.

Extensive use is made of chills, both metal and zircon sand, in order to more quickly solidify some sections.

Where it is necessary to keep some sections from solidifying in normal time, exothermic additions are made to sand which heat and insulate the desired location.

The position of gates on the casting is most important; the goal being to place the hottest metal in the risers while introducing cooler metal (heat lost through filling the mold) to the first-to-solidify sections. Introducing a large volume of steel in a localized area superheats the mold or core and retards solidification in that area.

Proper selection and use of materials to cover the liquid steel after filling the casting are critical. Large variations can exist in the insulating value of "pipe

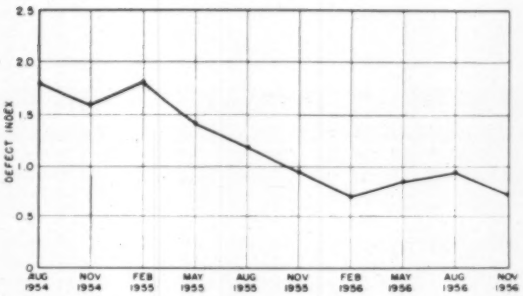


Fig. 3 Defect index for turbine shells and valves, 1954 to 1956

eliminators." Poorly chosen materials can result in shrinkage and/or metal contamination. Where it is desirable and necessary, highly exothermic material is placed at proper times on the riser metal to add heat.

Hot Tears. These defects are caused by the lack of ductility in the cast material near the solidification point. Areas which are very slow in solidifying compared to other sections of the casting are susceptible to hot tears. Even with the best designs, it is sometimes necessary to increase the solidification rate of these critical spots by the addition of external or internal chills. Internal chills are of the same composition as the casting and are thoroughly cleaned to insure proper fusion.

The composition and condition of sand molds and cores are very important since sands can develop compressive strengths exceeding the tensile strengths of steel at the temperatures involved and thereby cause tearing. The expansion characteristics of sand mixes are important since excessive expansion of cores surrounded by contracting metal is a major source of tears. Specific sand mixes with the lowest high-temperature strength and expansion are selected for each individual casting, consistent with other casting requirements.

The amount and form of sulfur and phosphorus in the steel determine to a large extent the resistance to tearing. To lower the number and severity of tears, these elements are kept at a minimum. The current level of 0.009 per cent S and 0.012 per cent P to some extent accounts for the decrease in hot tears.

Tears are also initiated by premature moving of the casting after pouring. Strain produced in improper or untimely moving operations can easily tear the metal during a sensitive period.

Cracks. Most cracks occur because the transition temperature of the material greatly exceeds ambient temperatures during the burning of risers, and so forth. The alloy was a high transition temperature (> 300 F) in the as-cast condition, which is lowered enough by full annealing to allow flame cutting and powder washing without cracking, if adequate preheat (390 F) is used followed by a slow cool after burning. Vanadium, carbon, nitrogen, and phosphorus levels are carefully controlled or held to a minimum. Cracking can be greatly aggravated by the presence of hydrogen "flaking." Therefore the melting practice was developed for low-hydrogen steel.

Gas. "Gas" defect usually refers to holes in casting where no solid material can be found. In most cases, these defects are located on the top side of the casting in its pouring position. Much of this gas defect can be controlled by careful use of strong deoxidizers (Al, Ti, Zr, and so forth, where strength and ductility will not be affected). Titanium is satisfactory if very low sulfur levels (0.015 max) are held in order to insure proper sulfide distribution and to obtain the specification reduction of area (50 per cent min).

Gas defects can occur because of washing of sand particles (and attached carbonaceous material) into the casting. Where large volumes of steel run over the sand, the mix is selected which will best resist washing and cutting. Improper curing and venting of molds or cores can result in out-gassing during the pouring operation. Vents are widely employed in order to aid the escape of gas, while cores or molds which are not cured are returned to the oven for additional treatment.

If inadequate deoxidation is employed, the evolution of CO gas can occur in the casting prior to solidification. The proper silicon level is insured from in-process chemical control.

Sand. Probably one of the most common defects in casting is sand. Defects will vary in extent from small individual sand grains to chunky pieces of sand aggregate. Improper formulation of sand mixes, incorrect ramming of cores and molds, inadequate control of curing, and poor gating and pouring all can introduce varying amounts of sand into a casting.

The foundry industry has much progress to make in minimizing sand defects. Many of the new materials and processes (sodium-silicate bonded sand and low-temperature curing oils) recently introduced will no doubt play an important part in keeping sand out of castings.

Many of the problems of ten and even five years ago which perplexed the foundry have found solution by improvement in technology and controls. With improved knowledge and control, and additional use of the scientific approach, the allowable stresses for 1% Cr-1% Mo-1/4% V material may again be increased, and defect volumes of castings can be reduced another 60 per cent from their present level.

Table 2 Comparison of Chemical Ranges and Control of B50A154-B

	1953			1956		
	Mean	Standard deviation	95.5 per cent within	Mean	Standard deviation	95.5 per cent within
Carbon, per cent	0.167	0.015	(0.15–0.20)	0.164	0.012	(0.15–0.20)
Silicon, per cent	0.37	0.07	(0.24–0.50)	0.40	0.07	(0.26–0.54)
Manganese, per cent	0.66	0.04	(0.58–0.74)	0.73	0.05	(0.64–0.82)
Sulfur, per cent	0.021	0.003	(0.015–0.028)	0.009	0.001	(0.007–0.011)
Phosphorus, per cent	0.024	0.004	(0.017–0.031)	0.012	0.002	(0.010–0.014)
Chromium, per cent	1.00	0.08	(0.83–1.17)	1.05	0.05	(0.95–1.15)
Molybdenum, per cent	0.97	0.08	(0.81–1.13)	1.04	0.04	(0.96–1.11)
Vanadium, per cent	0.18	0.02	(0.14–0.22)	0.21	0.02	(0.17–0.24)

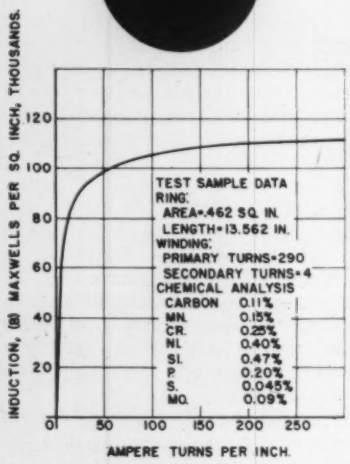


Fig. 4 Normal magnetization curve of dynamo steel for a typical sample of material

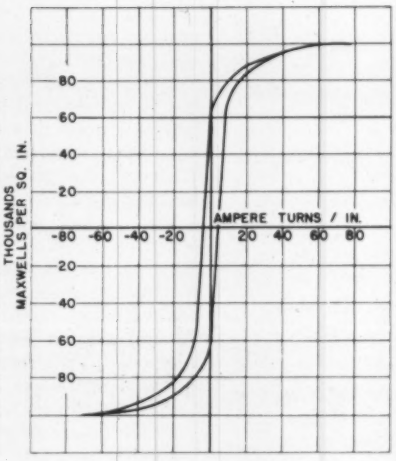


Fig. 5 Hysteresis curve of dynamo steel annealed, result of reducing magnetizing force to 0 and reversing it

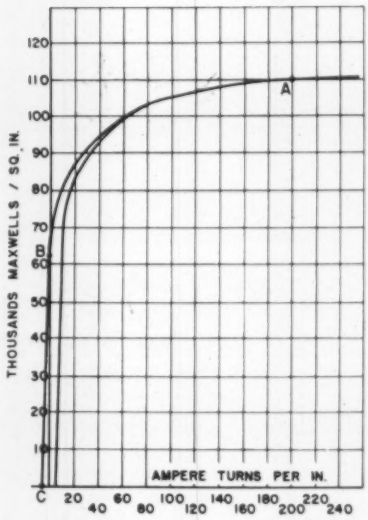


Fig. 6 Hysteresis curve illustrating the saturation flux (A), residual flux (B), coercive force at (C)

Design Characteristics of Magnetic Steel Castings[1]

THE design and operation of magnetic clutches and brakes are influenced directly by the magnetic characteristics of the available materials. Dynamo cast steel offers many characteristics desired for design of these units when castings are to be used.

As in many products, elements of clutches and brakes can be manufactured by fabricating and assembling stampings, or by use of castings. The decision is often dictated by production quantities, numbers of parts in an assembly, and other factors, all of which ultimately affect cost.

When high production and simple designs are considered, Armco magnetic ingot iron in sheet-stock form is ideal. It has excellent die-forming properties and excellent magnetic properties. Cast designs were avoided until recently because cast iron had very poor magnetic properties. In recent years improvements in low-carbon steels have given us dynamo steel. Dynamo cast steel, similar to Armco iron, is considered ideal whenever costs and design favor castings. It also has excellent magnetic properties.

Two Important Characteristics

In most electromagnetic machines the two main magnetic characteristics desired are high induction and low coercive force. In a direct-current electromagnetic device, these characteristics simply mean a high magnetic attraction when the current is on and a low residual attraction when the current is off. Induction is measured in Maxwells, or lines of flux, and the flux density is measured in Maxwells per sq in.

Induction. Induction or magnetic flux B is related to the attractive force F by the relation

$$F = \frac{B^2 A}{72} \times 10^{-6}$$

where B = magnetic flux in Maxwells per sq in.
A = pole area in sq in.
F = force in lb

Coercive Force. Coercive force is the amount of demagnetizing force required to reduce the induction to zero, and is measured in ampere turns per in. These are important whether the attraction is used for lifting and holding or for creating friction.

Magnetization Curve

The normal magnetization curve of dynamo steel is shown in Fig. 4. Induction versus magnetizing force is plotted for a typical sample of material. The normal magnetization curve is a trace of the original magnetization of a carefully demagnetized test ring. At a high magnetizing force the saturation flux for various materials in the low-carbon range does not vary greatly. The coercive force does vary considerably for steels of differing chemical composition and heat treatment, and this characteristic will be given special consideration.

Hysteresis Loop. The hysteresis loop, Fig. 5, is the result of reducing the magnetizing force to zero and reversing it to an equivalent force in the negative direction. This curve will be retraced each time the current is reversed. All of the devices considered will be operating repeatedly, therefore this curve has the most application to their design.

Magnetic Attraction. Only the top portion of the hysteresis curve which will be described further is shown in Fig. 6. Point (A) illustrates a value of 110,000 Maxwells per sq in. at a magnetizing force of 200 amp turns per in. This value of flux, for instance, would create a pull at the

[1] From the paper by William C. Pierce, senior project engineer, Warner Electric Brake & Clutch Company, Beloit, Wis.

pole face of 139 psi. In a closed circuit, that is, one with no air gaps, the flux would still be 65,000 lines per sq in. after the current was removed. This is represented by point (B) and would result in a residual magnetic attraction of 58 psi. If a small reverse potential (coercive force) is applied, the flux quickly drops to zero as shown at point (C). An air gap in the circuit will also act as a reverse potential also, as will be shown.

Residual Magnetism. The portion of the curve to the left of the zero-coercive-force ordinate is especially significant for studying residual magnetism. Fig. 7 shows this portion, and several curves representing different materials are also shown for comparison. This is used as a residual calculator. Curve (D) for example is a typical curve of dynamo steel annealed at 1600 F, and (E) represents the same piece unannealed. If dimensions of the magnetic circuit including the air gap are known, the permeance coefficient can be determined. These values are represented by radial lines. You will realize shortly that a small air gap will reduce the residual magnetism drastically. If a permeance coefficient of 1000 were determined, and the material was annealed dynamo steel, the intersection of the radial line and curve (D) is at the flux level of 12,000 lines per sq in. This would result in a pull of only about 2 psi. If the material were not annealed, the intersection with curve (E) would indicate a flux level of 27,500 lines per sq in. The pull due to this magnetic density would be about 10 psi. This emphasizes the importance of annealing dynamo steel to minimize these residual forces.

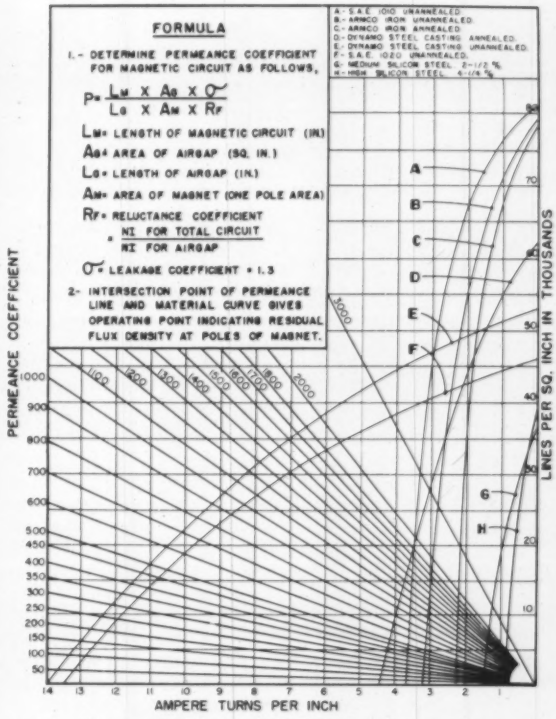

FORMULA
1.- DETERMINE PERMEANCE COEFFICIENT FOR MAGNETIC CIRCUIT AS FOLLOWS,
P = Lm X Ag X σ / Lg X Am X Rf
Lm = LENGTH OF MAGNETIC CIRCUIT (IN.)
Ag = AREA OF AIRGAP (SQ. IN.)
Lg = LENGTH OF AIRGAP (IN.)
Am = AREA OF MAGNET (ONE POLE AREA)
Rf = RELUCTANCE COEFFICIENT = NI FOR TOTAL CIRCUIT / NI FOR AIRGAP
σ = LEAKAGE COEFFICIENT = 1.3
2.- INTERSECTION POINT OF PERMEANCE LINE AND MATERIAL CURVE GIVES OPERATING POINT INDICATING RESIDUAL FLUX DENSITY AT POLES OF MAGNET.
A - S.A.E. 1010 UNANNEALED.
B - ARMCO IRON UNANNEALED.
C - ARMCO IRON ANNEALED.
D - DYNAMO STEEL CASTING ANNEALED.
E - DYNAMO STEEL CASTING UNANNEALED.
F - S.A.E. 1020 UNANNEALED.
G - MEDIUM SILICON STEEL.
H - HIGH SILICON STEEL.
PERMEANCE COEFFICIENT
LINES PER SQ. INCH IN THOUSANDS
AMPERE TURNS PER INCH

Fig. 7 Residual calculator for low-carbon steels showing the portion of the curve to the left of the zero-coercive-force ordinate

Varying Characteristics

Annealing Dynamo Steel. A great variety of results can be obtained by various annealing cycles and aging treatments. An anneal cycle for general use where residual is to be kept low is as follows:

Anneal temperature is 1600 F maintained for $1^1/_2$ hr, followed by cooling at a rate of 100 deg per hr to 800 F, air cool from 800 F.

Effect of Chemical Composition. Since Fig. 7 also shows that, as a general trend, increased carbon content increases the coercive intensity, the residual magnetism is higher. As an extreme illustration, hardened high-carbon steels are well known as permanent magnets, and the coercive force may be hundreds of times that of any material illustrated here.

Silicon has the effect of minimizing the coercive force and increasing electrical resistance. This is important in alternating-current devices to minimize the hysteresis losses. Silicon steel is used in thin sheets to make laminated assemblies for solenoids, transformers, and the like.

An interesting metal that produces very high flux densities is ferrocobalt, but it is rarely used because of its high cost.

Fig. 8 Casting of dynamo steel to be used as a rotor for an 8 1/4-in. diam electromagnetic clutch

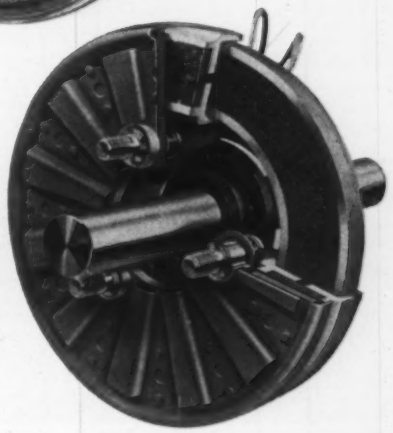


Fig. 9 Sectioned view of Warner size 825 stationary field clutch employing the dynamo-steel casting shown in Fig. 5

Foundry Practice

Certain considerations must be observed by foundries when using dynamo steel which has a high freezing temperature. If splatter or turbulence is encountered while pouring a casting, a laminated section may be developed. Proper gating of the molds is necessary to minimize this. The higher temperatures encountered also result in increased shrinkage over low-carbon steel castings.

Examples of Magnetic Castings. A typical casting of

dynamo steel is shown in Fig. 8. This is a casting that becomes a rotor for an SF-825 industrial clutch shown in Fig. 9. Friction material is bonded between the two poles of the rotor. The poles attract the armature and develop pressure on the friction surface between the members. Dynamo steel permits a fairly low wattage coil requiring only 30 watts to create a very high flux density at the pole surfaces. The radial air gaps permit the field member which contains the coil to be mounted stationarily while the rotor revolves about it with a small radial clearance.

All of the magnetic parts—field, rotor, and armature—require good magnetic properties and therefore can be made from dynamo steel. The rotor is especially suited to cast design, and dynamo steel is invariably used in these parts.

Machining Dynamo Steel

Dynamo steel is very soft, and tricky to machine. Some machinists describe it as "gummy" and can readily identify the material by observing its machining characteristics. Proper tools, however, can be made to permit good finishes in production. A typical machining rate of 500 fpm is possible. In general, the tools are ground with a 30-deg minimum rake angle and tight chip curler.

Wear Rate and Specifications

The softness of this material results in fairly high wear rates, therefore in clutches and brakes friction materials are necessary to reduce the pressure and so minimize wear. This face-wearing characteristic is used to good advantage since a run-in or burnishing period for clutches and brakes is necessary to obtain maximum torque. To permit this the friction material is usually slightly undercut to allow the poles to score a track in the armature before the friction material bears on the armature. The friction material decreases the wear rate and stabilizes the resulting torque.

In most cases a foundry casts dynamo steel to specifications set up and agreed upon between the foundry and user. No industry-wide standards have been agreed upon. The specifications used by Warner Electric Brake & Clutch Company are as follows:

Physical properties		Chemical analysis	
Tensile	45,000 psi min	Carbon	0.12 max
Yield	30,000 psi min	Manganese	0.15 max
Elongation	30 per cent min	Silicon	0.45 max
Reduction in area	45 per cent min		

The Future

Great strides have been made in recent years in improving the magnetic properties of cast steel to the present point. In general, the goal is to decrease carbon content and residuals. The saturation flux can thereby be increased slightly and coercive force reduced considerably. At present it is representative to obtain dynamo steel with a carbon content of 0.07 to 0.08 per cent carbon—well under our specification. As processes are improved, steel with carbon contents down to 0.02 to 0.03 will be used extensively for improved magnetic parts.

The Use of Nondestructive Testing on Steel Castings for Elevated Temperature Service[4]

Large, intricate steel castings play a major role in steam turbine manufacture. The steady increase in operating efficiencies of power plants has resulted from higher operating temperatures and pressures. All materials used in steam-turbine construction, including steel castings, must be carefully produced using the combined talents of design engineers, materials engineers, metallurgists, and foundry engineers. The nondestructive test methods are indispensable tools for the production of the quality steel castings used in this service. These methods are used to insure casting quality and also as an aid to improved foundry techniques. (Fig. 10.)

The nondestructive test methods in common use for steel castings for elevated-temperature service are (5, 6): Visual examination, radiography, magnetic-particle examination, and ultrasonic inspection.

Visual Examination

Visual inspection is most extensively used, since it is easily applied, is a rapid and inexpensive method, and yields important information for the determination of dimensional accuracy and conformity to drawing requirements. The surface condition of the casting is also examined to detect discontinuities such as hot tears, cracks, sharp folds, or notches which will act as stress raisers, and which should be corrected. In most instances, highly stressed areas, or often the entire area, will be further examined by magnetic-particle inspection.

Radiography

Radiography (7) is most helpful in establishing suitable foundry practices. It is likewise an effective tool in determining the degree of solidity and internal integrity of highly stressed or important areas of casting. Discontinuities in the order of $^1/_2$ to 2 per cent of the thickness under study can be detected. These include shrinkage cavities, gas or porosity, sand inclusions, and internal hot tears. Cracks may or may not be detected depending upon their location in relationship to the source of radiation.

Many foundries use radioisotopes for radiographic ex-

[4] From the paper by Clyde B. Jenni, chief metallurgist, General Steel Castings Corporation, Eddystone, Pa. Mem. ASME.

amination. For common sections 1 in. and greater, cobalt-60 is generally used. This yields good results up to 6 in. and fairly good results up to 8 in. Iridium-192 is generally used when section thicknesses are in the range of 0.5 to 2 in. X-ray equipment of 250 kv is normally used for wall thicknesses up to 2 in., 1 Mev up to 5 in. wall thickness; 2 Mev up to 8 in. in wall thickness. The betatrons 15 Mev and 22 Mev can be used in sections up to 16 in. in thickness, and by certain practices can be used for limited work on even heavier sections.

Most of the radiographic work done by the author's company in the inspection of large turbine castings is by means of a 22-Mev industrial betatron (8), shown in Fig. 11, which is suspended from a bridge crane by a telescoping tube assembly. The unit can be raised and lowered, can be moved forward and backward by the crane, and, in addition, can be revolved and angulated. This maneuverability makes it practical to radiograph large castings up to 20 ft in length in a variety of shapes.

ASTM E-71-52, "Industrial Radiographic Standards for Steel Castings," forms the basis for acceptance of the castings. Castings for high-pressure and high-temperature service generally have wall thicknesses over 1 in., and must conform to Class 2 Standards or better. Low-pressure-service castings must comply with the requirements of Class 3 Standards. There are, of course, exceptions to these broad classifications.

Discontinuities which are gross in nature, or are of the type which can serve as stress raisers, must of necessity be removed if they occur in areas of large stress concentration or of vital importance. They may be left without harm in areas of neutral or low stress.

Experienced inspectors are guided by a knowledge of the intended operating conditions such as pressure, temperature, and stress in interpreting the information yielded by radiography.

In addition to the cracks, hot tears, and unfused chaplets or chills, other defects are unacceptable because of area location. Weld preparations for *field* fusion welds must be free from sand, shrinkage-porosity, or spongy metal for a minimum of 3 in. back from the edge of the weld preparation, a more stringent requirement than even Class 1 of ASTM E-71-52. Where the fusion welding is performed by the turbine builder, the minimum distance is T inches, and maximum 3 in., where T is the thickness of the casting wall. Defects near the cored holes, valve-seat bores, or other machine areas must be considered acceptable or rejectable on the basis of their proximity.

Defects unacceptable due to depth location are spongy metal at or near the surface, and gas holes visible on the surface that exceed in depth 10 per cent of the wall thickness or exceed the quantity shown on ASTM Radiographic Standards Group A-3.

A defect acceptable with depth qualification is centerline shrinkage in areas of uniform wall thickness as long as it remains in the middle third of the wall thickness.

General considerations in inspection are: (*a*) Primary shrinkage or piping, when occurring in areas of section changes, must be judged in accordance with stress considerations, orientation, and depth. (*b*) Gas and blow holes in general throughout the wall thickness should not exceed Class A-3 of ASTM Radiographic Standards. (*c*) Sand spots and inclusions in general should not exceed Class B-3 of ASTM Radiographic Standards.

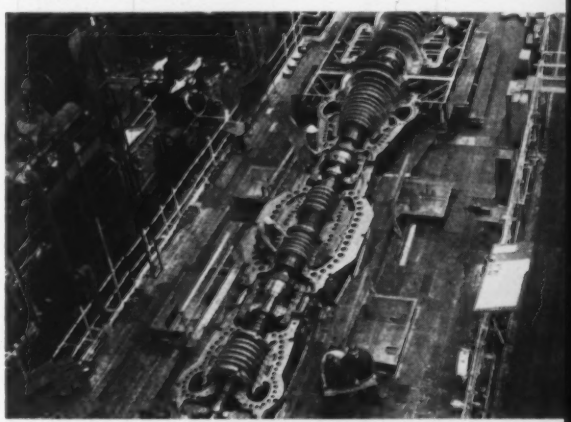
All harmful visible defects and those found by radiography, and judged harmful by the application of the above principles, are removed by chipping, grinding,

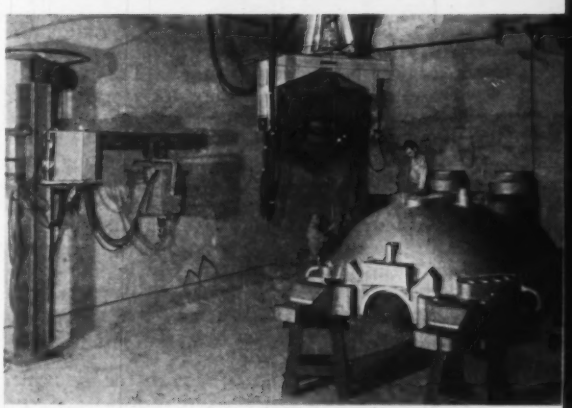
Top to bottom:

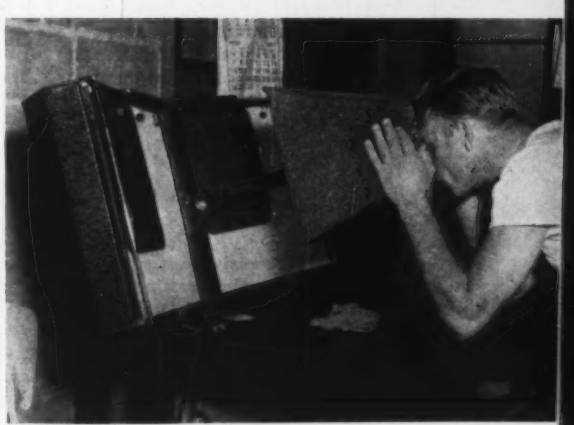
Fig. 10 Steam turbine being assembled for test. The view shows the use of the large steel castings.

Fig. 11 A 22-Mev industrial betatron and 250-kva x-ray unit. The betatron is being positioned to examine a large turbine casting.

Fig. 12 Stereo-radiographic views obtained by making two exposures at slightly different angular projections can be interpreted by a skilled reader using a stereo viewer







Left to right:

Fig. 13 Magnetic-particle inspection of a large steam-turbine casting using a rectifier unit and spray gun

Fig. 14 View of magnetic-particle inspection where portable equipmen is being used on large steam turbine castings

Fig. 15 Ultrasonic reflectoscope in use on a large steam-turbine casting

flame cutting, powder washing, or arc-air methods under properly controlled conditions. The completion of defect removal is checked by visual examination, magnetic-particle testing, or additional radiographic examination. When the defects are removed, the castings are repaired by welding, using carefully controlled procedures and qualified welding operators. After repairs, the castings are given either a stress-relieving heat-treatment or their regular heat-treatment. The welded areas are then dressed by chipping and grinding or by flame cutting, and are examined by magnetic-particle inspection. No fixed rules exist whereby decisions are made as to whether or not a weld repair should be radiographed. The following factors are suggested as criteria which might be used. The areas should be radiographed if: (*a*) The area penetrates the wall thickness of the part. (*b*) The defect area is within 3 in.of a field-weld preparation regardless of its size. (*c*) The defect occurs in an area which requires radiography.

Generally, acceptance is based upon the principles of the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels, however, there are some inspectors who have much more stringent requirements. ASTM E-99-55T, "Tentative Reference Radiography for Steel Welds," is considered applicable primarily for fabrication welding but has not been applied on planned welding or repair welding of large steel castings. The acceptability of welds examined by radiography could be judged by the following criteria:

1 Welds in which the radiographs show elongated slag inclusions or cavities are unacceptable if the length of these imperfections is greater than $^1/_3$ *T*, where *T* is the thickness of the inner wall welded. If several imperfections within the above limitations exist in a line, the welds are judged acceptable, if the sum of the longest dimensions of all such imperfections is not more than *T* in a length of 12 *T* and if the defects are separated by at least 6 *L* of weld metal, where *L* is the length of the longest imperfection. The maximum length of acceptable inclusion for any wall thickness is $^3/_4$ in. Any slag inclusion shorter than $^1/_4$ in. is acceptable for any wall thickness.

2 Welds whose radiographs show any type of crack or incomplete penetrations are unacceptable.

3 Acceptability or rejection of welds in which the radiographs show porosity is based upon comparison with ASME Boiler Code Standards.

Stereo-Radiography

Stereo-radiographic views can be obtained by making two exposures of an area at slightly different angular projections. This is accomplished by shifting the radiation source and the film, with respect to the area under examination, by an amount roughly equivalent in angle to the eye-spacing at the intended viewing distance.

Special viewing equipment is used which enables visualization in three dimensions. Fig. 12 shows such viewing equipment with the two radiographs in place.

This procedure is used when there is some question as to whether a shrinkage area lies in the middle third of the section or whether it may be located at or near a highly stressed or critical area. The stereo study may determine whether a repair is necessary and indicate the best place of attack so that there will be a minimum amount of sound metal removed.

Successful stereo-radiography depends largely on the skill of an interpreter well versed in the reading of film, and a familiarity with the configuration of the type of casting. Since many operators have difficulty in discerning the true perspective and correct spatial relation, a second or double-exposure method (9) can be used.

Lead markers are fastened to the front and back of the specimen. Two exposures are made, the tube being moved a known distance between them. This is 10 in. with the company betatron. The position of the rear marker will change very little, while the shadow of the front marker and the flaw will change by a larger amount.

The two exposures are superimposed so that the shadows of the back marker coincide; the shift of the flaw image is then measured. The distance of the flaw from the film can then be calculated by

$$d = \frac{bt}{a + b}$$

when

d = distance of the flaw above the film plane
a = tube shift
b = change in position of the flaw image
t = focus film distance

A chart which shows the relationship between the shift of the flaw image in thousandths of an inch and the distance the flaw lies above the film has proved quite useful in our plant.

This same technique has also been used to measure the thickness of a casting section where conventional methods prove difficult by measuring the shift of the front lead marker on the film.

Magnetic-Particle Testing

Magnetic-particle examination (10) and (11) is used to disclose surface discontinuities not usually found by normal visual inspection. The dry-powder method using finely divided particles of distinct colors applied by an air gun or applicator is generally used on the casting surfaces. The wet method, or a suspension of indicator particles in a suitable liquid medium, is used on machined surfaces and, in some instances, on areas of defect removal prepared for welding. A defect establishes a leakage field producing local magnetic poles which attract the particles.

All steel castings for pressure service are completely inspected on all accessible surfaces, in accordance with ASTM E-109-55T, "Tentative Method for Dry Powder Magnetic Particle Inspection." Portable equipment and a large rectifier unit of 3000-amp capacity are used. This equipment, Figs. 13 and 14, permits magnetization of an area up to 20 × 24 in. and is of considerable value when large surfaces are to be examined. Special contactors made up of motor shunts, or woven-copper braiding, are used in place of the conventional prods.

Casting surfaces must be properly cleaned, preferably by pressure blasting, and must be free of oil, adhering sand, and scale. All indications are marked and evaluated (12); any questionable indications are rechecked by grinding the area and retesting.

In general, all indications are explored. If they are small and clearly identified as small isolated inclusions not located in a weld-preparation area, they are acceptable. In many cases the source of the indication is fairly superficial and is removed by a light chip or by grinding, and is blended into the casting surface.

Indications which identify cracks, hot tears, large areas of sand, shrinkage, inclusions in a weld-preparation area, unfused chaplets or chills, are further investigated by chipping or flame burning. The discontinuities are thus removed, and the area is retested to insure completeness of defect removal.

All repair welds after stress relieving or regular heat-treatment are dressed down and are given a magnetic-particle inspection. Weld porosity, incomplete penetration, undercutting, inclusions, crater cracking, and weld cracks are readily disclosed and the necessary corrective measures taken.

Ultrasonic Inspection

Ultrasonic testing is generally used on finished surfaces such as are found on a rotor forging (13). Successful results have been achieved, however, using the reflectoscope method on the cast surfaces of castings which have been heat treated (14). It is important that the cast surfaces be ground prior to the test to a surface of about 100 microin. so that with the use of the proper couplant the sound waves can enter and penetrate the casting wall. Fig. 15 shows the reflectoscope in use on a large turbine casting.

While the ultrasonic reflectoscope is a tool used only to a limited degree in the steel foundry, it has potentialities for greater use as more experience is gained and much correlation with radiography is accomplished.

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A 225,000-psi Commercial Cast Steel[5]

TACONITE mining operations in northern Minnesota call for special properties in cast-steel mining-equipment parts. The abrasive wear of the flint-hard taconite required high hardness, a yield strength that would prevent deformation under load, and high resistance to impact loading conditions at operating temperatures as low as −50 F.

The Manufacturing Research Laboratory of American Steel Foundries developed a complex low-alloy cast steel, called Wearpact, with outstanding mechanical properties, which has successfully met the test of commercial use.

Steel castings can furnish such excellent properties since they lack directionality of mechanical properties. They are composed of equiaxed grains and contain globular or crystalline nonmetallic inclusions whose size and dispersion are controllable by application of present knowledge of deoxidation practice and solidification characteristics of molten steel.

In the past, designers have made forgings or fabrications of components which, by nature of their shape, complexity, or function, should logically have been cast, and which made design difficult for overcoming the mechanical properties of wrought steel.

Wearpact is a complex low-alloy steel using a minimum of critical materials. Nominal composition for the production of castings of 4-in-max section thickness is of the following percentages: carbon, 0.23 to 0.33; manganese 1.30 to 1.80; silicon, 0.30 to 0.60; chromium, 0.4 to 1.00; molybdenum, 0.40 to 0.70. The steel is alloyed with boron for increased hardenability. Alloy additions of rare-earth metals insure the formation of globular inclusions and improve ductility and resistance to impact. Aluminum used in the deoxidation process makes inherently fine-grained steel and assists in the development of high resistance to impact loading.

Castings of this alloy are quenched and tempered to produce a microstructure consisting of low-tempered martensite, the toughest high-strength material currently known. A slightly more highly alloyed composition is being developed for maximum section thicknesses of 8 in.

The basic physical properties, such as density, thermal expansion, thermal conductivity, specific heat, resistivity, and others, do not differ significantly from any other low-alloy steel which has been heat-treated to a martensitic microstructure, and are not pertinent to the application of the material.

Magnetic properties are not as good as those for a good quality plain carbon magnet steel or a tungsten magnet steel, although magnetic stability under mechanical shock is very good. The very fact that the alloy is magnetic imparts some advantages not obtainable with austenitic wear-resistant steel. It permits magnetic scavenging, important in the preparation of certain ceramic materials where iron content must be low.

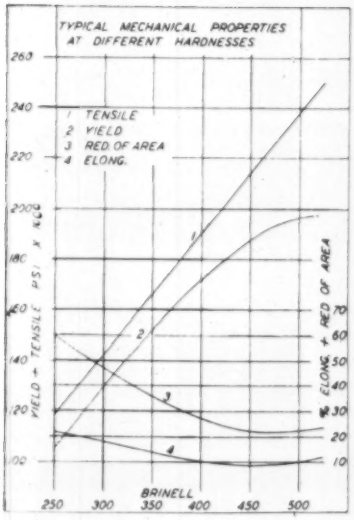
Additional applications have been found in abrasion-resistant parts such as crusher and chute liners. Greater load-carrying ability has proved useful in the production of lightweight grouser and tractor shoes.

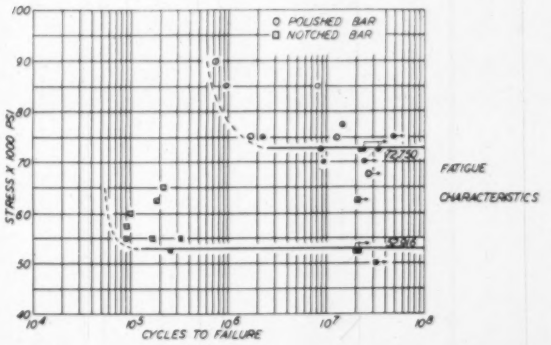
No bending has been encountered even after grouser bars have worn completely away, and breakage has been minimized under the most rigorous service conditions. An engineering redesign of a large track shoe resulted in a weight reduction of 32% without the sacrifice of structural strength. Casting weight was reduced from 280 lb to 190 lb, and because of the high yield strength of this alloy steel permitted the use of thinner tread and rib sections. In actual service tests the castings produced in this material have outlasted the regular grades by many hours. In addition, the wear and tear on the vehicles haev been greatly reduced, resulting in both direct and indirect savings to the customer.

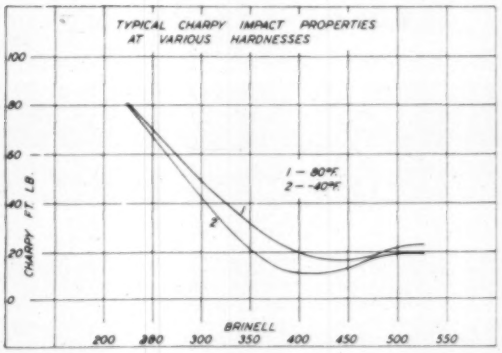
With the advent of new semiprecision high-quality molding procedures which have recently been developed, it is very possible that this high-strength steel will find many applications in aircraft components, automotive and industrial applications. Experience to date in mining applications has shown considerable promise in the use of this material for extremely high strength structural components. The designer, foundryman, and metallurgist can use the information developed in such applications in the design and production of component parts where high stress loads are a prime requisite. The newer molding techniques, such as shell molding, will produce the desired notch-free surface necessary for high-strength structural parts.

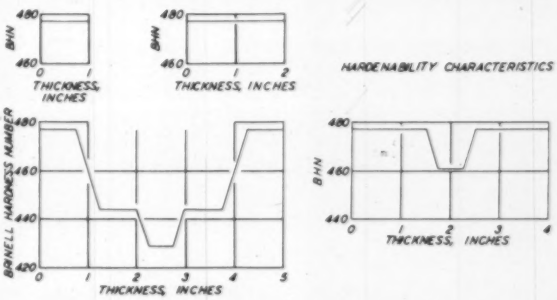
[5] From the paper by C. G. Mickelson, assistant manager, and R. D. Engquist, senior research metallurgist, American Steel Foundries, Manufacturing Research Laboratory, East Chicago, Ind.

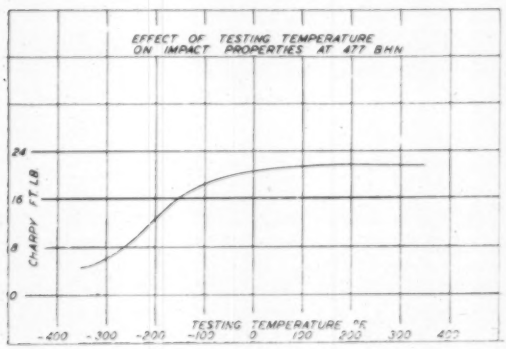
Characteristics of "Wearpact" Steel











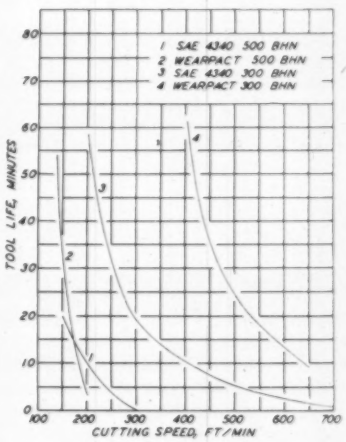


Table 3 Notched Static Tensile Test Data for Various Ultra-High-Strength Steels

Material	Normal tensile strength, psi	Notched tensile strength, psi	Notched reduction of area, per cent	Ratio of notched to un-notched tensile strength	Root radius of 60 deg deep, in.
SAE 2340[a]	230,000	310,000	3.0	1.34	0.010
SAE 5140[a]	230,000	315,000	3.0	1.36	0.010
SAE 1340[a]	230,000	290,000	2.0	1.26	0.010
SAE 1050[a]	230,000	280,000	1.5	1.22	0.010
SAE 4340[b]	230,000	300,000	...	1.30	0.010
Wearpact	230,000	308,192	9.1	1.33	0.010
Wearpact	230,000	291,000	...	1.27	0.001

[a] Brine quenched. [b] Oil quenched.

For the graduating class....

PROFESSIONAL REGISTRATION

By J. J. Uicker[1]

In many states, the newly graduated engineering student has an opportunity to take part of his state professional exams immediately, while his college training is fresh. He wins "Engineer-In-Training" certification. There remains "Qualifying Experience," and then he's a Licensed Professional Engineer.

So much of engineers' work affects the safety, health, and property of the public that all of the states in the U.S., acting in the public interest, limit the practice of engineering to registered persons.

By prescribing minimum standards for the registration of engineers, the several states prevent incompetent persons from offering to practice engineering. The engineering college students of today discover it is likely that either they must remain permanently in subordinate positions or they must become registered in order to take charge of important engineering work. It is to this composite group of students of engineering and to their professors that the subject matter of this paper is directed.

Requirements for Registration

One might ask, "What are the requirements for registration?" A general answer would be: A proper educational background, practical experience, and character qualifications. The state laws, in general, do not require that a person be a graduate of an engineering college, but they do require that he have the educational equivalent. Generally, the laws require engineering practice experience of a character satisfactory to the Board of Registration. This is usually a minimum of four years.

For over 30 years the important engineering societies, together with the National Council of State Boards of Engineering Examiners and the Engineers' Council for Professional Development, have concerned themselves with what is called the Model Law. The "professional engineer" is defined in the Model Law as "a person who, by reason of his special knowledge of the mathematical and physical sciences and the principles and methods of engineering analysis and design, acquired by professional education and practical experience, is qualified to practice engineering."

The Model Law states: "The practice of engineering shall mean any professional service or creative work requiring engineering education, training, and experience, and the application of special knowledge of the mathematical, physical, and engineering sciences to such professional services or creative work."

The requirements for registration are: An acceptable diploma and a "specific record of an additional four years or more of experience in engineering work of a character satisfactory to the Board, and indicating that the applicant is competent to practice professional engineering."

The Engineer-In-Training

The college senior in engineering may ask what all of this has to do with him at present. He will find that he is almost ready to embark upon his pursuit of registration in engineering. In a great many states he can begin this pursuit immediately after he is entitled to his degree. This is known as Engineer-In-Training Certification.

The Engineer-In-Training movement is only 20 years old and is now in effect in some form in 36 of the states. In these states, and in some others which also require a written exam of all candidates for registration, the graduates of approved colleges of engineering may write the fundamentals parts of the examinations as soon as the requirements for the degree have been accomplished.

The fundamentals examination is usually an 8-hour examination. The Registration Bulletin, publication of the National Council of State Boards of Engineering Examiners, in September 1952, stated: "It is generally agreed that the Engineer-In-Training examination should cover 'fundamentals' as taught in approved engineering curricula. These fundamentals include mathematics through integral calculus, one year each of chemistry, physics, and mechanics (the latter including statics, kinetics, and strength of materials), and at least two of the following courses: electrical engineering, hydraulics or fluid mechanics, and thermodynamics or heat power."

The Engineer-In-Training movement is growing

[1] Former chairman (1957) of the ASME Engineers' Registration Committee; chairman, Mechanical Engineering Department, University of Detroit, Detroit, Mich.

rapidly. By the time that it is put into effect generally throughout the nation, most of the recent graduates of engineering colleges will have written successfully the engineering fundamentals examination and be certified as Engineer-In-Training. Such persons will then need only to complete the necessary minimum experience acceptable to the particular State Board and to pass the practice examination (if one is required) to become registered. Until the Engineer-In-Training movement began, no candidates for registration were permitted to take any parts of the examinations in any of the states until they had acquired the minimum necessary experience.

The Professional Registration Boards, as well as the National Council of State Boards of Engineering Examiners, are doing everything in their power to see that new graduates in engineering are given the opportunity to obtain their licenses. These boards do not have the opportunity of reaching many students who should be advised in this matter. The proper way to handle this is through the engineering schools themselves. It is a sad fact that many engineering graduates are leaving their college campuses without knowledge that a license is necessary to practice.

THE ASME POLICY

The Council of ASME, on April 6, 1956, adopted the policy which endorses and supports the registration of professional engineers as being in the best interests of the engineering profession and the general public. In support of this policy, ASME:

1 Approves in principle the Model Law and pledges to co-operate with other sponsoring groups in its revision, subject to approval by the Council.

2 Offers its facilities to assist in the appropriate revision or modification of registration acts in States where responsible organizations request such assistance.

3 Supports financially the activities of the National Council of State Boards of Engineering Examiners and gives advice and assistance to the Council when requested.

4 Recommends that there be no discrimination by implication, omission, or direction as to the form of business organization (individuals, partnerships, corporations, or others) under which the practice of engineering is conducted provided that the person or persons in responsible charge of such practice be legally registered professional engineers.

5 Recommends that each Section appoint a standing committee known as the Registration Committee to co-operate with the State Registration Board and the Section Program Committee in the dissemination of information.

6 Recommends that each Section devote some time in a Section Meeting each year to the subject of engineering registration where, if possible, a member of the State Registration Board would address them.

7 Recommends that, in States in which written examinations are required of applicants for registration, Sections co-operate with other groups in sponsoring refresher courses.

8 Recommends that each Student Section devote a session to engineering registration where, if possible, a member of the State Registration Board or a prominent registered professional engineer would address them, placing special emphasis on the purpose of registration, the standards required for registration, the Engineer-in-Training program.

Do It Now

At the college senior level the Faculty, and Student Branch Officers of the respective professional societies, should help the students to prepare to write the Engineer-In-Training examination at the first opportunity following graduation. This will, for the majority, occur within a few weeks. Most graduates will never be better prepared to write a comprehensive examination in engineering fundamentals than they are at that time. Many who do not do so, regret it later.

There should be no group more interested in the development of the engineers of tomorrow and in the growth and stature of the profession than the engineering teachers. They should be concerned with the engineering license laws in the several states. They are in a position to emphasize the importance, the advantages, and the methods of obtaining engineering registration. They should advise their students on Engineer-In-Training recognition and when the license examinations are held. They should give them encouragement and advice as to what they may expect in the nature of the examinations.

Mr. Edward J. Nunan, President of the New York State Society of Professional Engineers, in an address delivered at the Middle Atlantic Section of ASME at Manhattan College on December 6, 1952, stated: "I am firmly convinced that every engineering school in the country should follow these lines of thought. It is the hope of our society that eventually all of those teaching engineering in colleges will recognize the importance of obtaining licenses of their own, and in this way impress upon all of their students the benefits to be derived from professional licensure, which in turn will make engineering the profession it deserves to be."

Get the Right Experience

The young engineer should be careful in his selection of employment to see to it that he gains qualifying experience. The several states differ in their exact requirements. The Model Law is a good general measuring stick.

Do not accept the opinions of those only casually acquainted with the law. This often leads to misconceptions and loss of valuable time. The most satisfactory way of securing up-to-the-minute information concerning the law covering the practice of engineering in a particular state is to get a copy from the State Registration Board. The Secretary of the National Council of State Boards of Engineering Examiners (NCSBEE), P.O. Drawer 1404, Columbia, South Carolina, can supply the address of any of the member State Boards.

The spring back of coil springs

By Frank J. Gardiner[1] and Harold C. R. Carlson[2]

How to calculate the exact arbor diameter required to produce a specified outside diameter of spring for any material, and a comprehensive set of tables based upon the formulas

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[3]"The Spring Back of Metals," by F. J. Gardiner, Trans. ASME, vol. 79, 1957, pp. 1-9.

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When hardened spring-steel wire is coiled around an arbor or mandrel a considerable amount of springback occurs. The springback varies with each size of wire, type of material, tensile strength, yield point, spring index (OD/d), and arbor diameter. For many years it has been the custom for springmakers to keep a record of the arbor diameter required to produce a desired outside diameter of spring. However, these records often were incomplete and inaccurate and varied from shop to shop. Trial and error were frequently resorted to for determining correct arbor diameter.

The purposes of this paper are: (a) To provide formulas, curves, and instructions whereby a designer can calculate the exact arbor diameter required to produce a specified outside diameter of spring for any material provided the tensile strength, wire size, and a few other factors are known. (b) To provide a comprehensive set of tables, based upon the formulas, that list the arbor diameters required to obtain certain outside diameters of springs made from popular sizes of music wire.

In "The Spring Back of Metals," by F. J. Gardiner,[3] the author presented a mathematical analysis, a derivation of formulas, and a set of curves for the springback of sheet metal made from aluminum, titanium, stainless steel, and other materials when formed by punches and dies. Based on the results of this previous study, further investigation of springback of coil springs was undertaken as follows: (a) The elementary theory was extended to include wires of circular cross section, and dimensionless parameters were found. (b) Test springs were coiled from various materials in many sizes, and results plotted according to the theoretical parameters. (c) A detailed study of a typical stress-strain curve indicated the need for corrections to the elementary theory. These have been made. (d) An empirical generalized curve was fitted to the test data, and its equation transformed to a simple chart of curves and tables for ready use. (e) Additional springs were wound to check accuracy.

The basic theory is used only as a guide for the plotting of test data, and since it was detailed in the previous paper, only the essence is presented here.

Nomenclature

a = cross-sectional radius of wire, in.
D = mean diameter of spring, free position, in.
D_a = diameter of arbor used in winding spring = $2R - d$, in.
D_s = final outside diameter of spring (OD) = $2r + d$
d = wire diameter = $2a$, in.
E = modulus of elasticity in tension, psi
K = a parameter = RS/Ed
l = length of chord, in.
R = radius of spring (taken at center of wire cross section while wound on arbor), in.
r = radius of spring (taken at center of wire cross section after springback) = $D/2$, in.
S = ultimate tensile strength, psi. (Use exact value if known; otherwise use the average value from specifications.)

Subscripts

x = at location (X)
y = at yield point
o = original or during winding operation
f = final or to the finished spring

Table 1. Arbor Diameters Required to Produce Certain Outside Diameters for Springs Made From Music Wire

Upper figure in box is spring index (OD/d), lower figure in box is required arbor diameter, in.

d=wire diameter; OD=outside diameter;
Example: To find the arbor diameter required to make a spring with $\frac{3}{8}$=in. OD using 0.018=in. d, the answer will be found in the column headed $\frac{3}{8}$ in., opposite 0.018=in. d. The correct arbor diameter is 0.231 in.

d \ OD	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	7/16	1/2
.008"	7.80 .039	11.7 .060	15.6 .078	19.5 .093	23.5 .107	27.4 .119	31.3 .129						
.010"	6.25 .037	9.37 .060	12.5 .080	15.6 .099	18.7 .115	21.8 .129	25.0 .142	28.1 .154	31.2 .164				
.012"	5.21 .034	7.81 .059	10.4 .081	13.0 .101	15.6 .119	18.2 .135	20.8 .150	23.4 .163	26.1 .177	28.6 .189	31.3 .200		
.014"	4.47 .031	6.70 .057	8.95 .081	11.1 .102	13.4 .121	15.6 .140	17.9 .156	20.1 .172	22.3 .187	24.5 .200	26.8 .213	31.2 .234	
.016"	3.90 .028	5.88 .055	7.82 .079	9.77 .102	11.7 .123	13.7 .142	15.6 .161	17.5 .178	19.5 .194	21.5 .209	23.4 .224	27.4 .250	31.2 .271
.018"		5.21 .053	6.95 .077	8.68 .101	10.4 .124	12.1 .144	13.9 .161	15.6 .182	17.3 .200	19.1 .215	20.8 .231	24.3 .259	27.8 .284
.020"		4.68 .049	6.25 .075	7.82 .096	9.38 .123	10.9 .144	12.5 .165	14.0 .184	15.6 .203	17.1 .220	18.7 .237	21.9 .268	25.0 .296
.022"		4.26 .046	5.68 .072	7.11 .097	8.53 .122	9.95 .145	11.4 .165	12.7 .186	14.2 .206	15.6 .224	17.0 .242	19.8 .275	22.7 .305
.024"		3.91 .043	5.21 .070	6.52 .095	7.82 .120	9.12 .144	10.4 .166	11.7 .187	13.0 .207	14.3 .226	15.6 .245	18.2 .280	20.8 .312
.026"			4.81 .067	6.01 .093	7.21 .118	8.42 .143	9.62 .166	10.8 .187	12.0 .208	13.2 .228	14.4 .248	16.8 .285	19.2 .318
.028"			4.46 .064	5.58 .091	6.70 .115	7.81 .141	8.93 .165	10.0 .187	11.2 .208	12.2 .229	13.4 .250	15.6 .288	17.8 .323
.030"			4.17 .061	5.22 .088	6.25 .113	7.29 .138	8.33 .163	9.37 .187	10.4 .209	11.4 .229	12.5 .251	14.6 .291	16.7 .328
.032"			3.91 .057	4.89 .085	5.86 .111	6.85 .136	7.82 .161	8.79 .185	9.78 .209	10.7 .229	11.7 .251	13.7 .292	15.6 .331
.034"				4.59 .082	5.52 .109	6.43 .134	7.35 .159	8.26 .184	9.20 .208	10.1 .229	11.0 .251	12.9 .292	14.7 .333
.036"				4.34 .078	5.21 .106	6.08 .131	6.95 .156	7.81 .182	8.68 .206	9.55 .229	10.4 .250	12.1 .294	13.9 .333
.038"				4.12 .075	4.94 .103	5.76 .129	6.58 .154	7.40 .179	8.23 .205	9.04 .227	9.87 .251	11.5 .293	13.1 .335
.041"					4.57 .098	5.34 .125	6.10 .151	6.86 .176	7.62 .201	8.38 .226	9.15 .250	10.7 .294	12.2 .336
.0475"					3.95 .087	4.61 .115	5.26 .142	5.92 .168	6.58 .194	7.23 .220	7.90 .244	9.21 .293	10.5 .337
.054"						4.05 .103	4.63 .132	5.20 .160	5.79 .187	6.36 .212	6.95 .245	8.10 .287	9.26 .336
.0625"							4.00 .108	4.50 .146	5.00 .169	5.50 .201	6.00 .228	7.00 .280	8.00 .330
.072"								3.97 .129	4.35 .158	4.77 .186	5.21 .214	6.08 .268	6.95 .319
.080"									3.91 .144	4.29 .173	4.69 .201	5.47 .256	6.25 .308
.0915"											4.10 .181	4.77 .238	5.46 .293
.1055"												4.15 .215	4.74 .271
.1205"													4.15 .215
.125"													4.00 .239

9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1-1/8	1-1/4	1-3/8	1-1/2	1-3/4	2
25.6 .332	28.4 .357	31.2 .380											
23.4 .341	26.0 .367	28.6 .393	31.2 .415										
21.6 .350	24.0 .380	26.5 .406	28.9 .430										
20.1 .356	22.3 .387	24.5 .416	26.8 .442	29.0 .467									
18.8 .362	20.8 .395	22.9 .426	25.0 .453	27.1 .481	29.1 .506								
17.5 .367	19.3 .400	21.5 .432	23.5 .462	25.4 .490	27.3 .516	29.3 .540							
16.5 .370	18.4 .404	20.2 .437	22.0 .469	23.9 .498	25.7 .526	27.5 .552	29.4 .557						
15.6 .372	17.3 .407	19.1 .442	20.8 .474	22.6 .506	24.3 .536	26.0 .562	27.8 .589						
14.8 .375	16.5 .412	18.1 .448	19.7 .481	21.4 .512	23.1 .543	24.7 .572	26.3 .600	29.6 .650					
13.7 .378	15.2 .416	16.7 .456	18.3 .489	19.8 .522	21.5 .554	22.9 .586	24.4 .615	27.5 .670	30.5 .718				
11.8 .380	13.1 .422	14.5 .464	15.8 .504	17.1 .541	18.4 .576	19.7 .610	21.0 .643	23.7 .706	26.3 .763	29.0 .812			
10.4 .381	11.5 .425	12.7 .467	13.9 .509	15.0 .550	16.2 .589	17.3 .625	18.5 .661	20.9 .727	23.2 .792	25.5 .850	27.8 .906		
9.00 .379	10.0 .426	11.0 .468	12.0 .512	13.0 .556	14.0 .597	15.0 .639	16.0 .678	18.0 .753	20.0 .822	21.0 .889	24.0 .951	28.0 1.06	32.0 1.17
7.82 .370	8.69 .418	9.56 .466	10.4 .512	11.3 .555	12.1 .599	13.0 .641	13.9 .682	15.6 .765	17.4 .840	19.1 .911	20.8 .980	24.3 1.11	27.8 1.22
7.04 .360	7.81 .411	8.60 .461	9.37 .509	10.1 .554	10.9 .599	11.7 .641	12.5 .685	14.1 .772	15.6 .851	17.2 .930	18.7 1.00	21.9 1.13	25.0 1.26
6.15 .347	6.83 .398	7.51 .448	8.20 .500	8.88 .547	9.57 .597	10.2 .640	10.9 .685	12.3 .776	13.6 .860	15.0 .942	16.4 1.02	19.1 1.16	21.9 1.30
5.33 .327	5.92 .381	6.51 .433	7.10 .485	7.70 .535	8.29 .586	8.88 .630	9.47 .683	10.7 .775	11.8 .865	13.0 .952	14.2 1.04	16.6 1.20	19.0 1.35
4.66 .303	5.19 .358	5.71 .414	6.22 .468	6.74 .520	7.26 .571	7.78 .622	8.30 .673	9.35 .772	10.4 .864	11.4 .955	12.4 1.04	14.5 1.22	16.6 1.38
4.50 .295	5.00 .351	5.50 .406	6.00 .461	6.50 .515	7.00 .567	7.50 .617	8.00 .671	9.00 .770	10.0 .864	11.0 .955	12.0 1.05	14.0 1.23	16.0 1.39

Theory

As shown in the previous paper, moment of residual stress in the finished spring must be zero. Expressing this mathematically (see Fig. 1)

$$\int_{x=+a}^{x=-a} XS_{z_f}\, l dx = 0$$

As before, the stress-strain function is assumed to be represented by two straight lines thus requiring discontinuous integration.

$$S_{z_f} = \frac{XE}{r} \text{ for } 0 < S_{z_o} < S_y$$

$$S_{z_f} = S_y - XE\left[\frac{1}{R} - \frac{1}{r}\right] \text{ for } S_{z_o} > S_y$$

After solving this integral equation and substituting K as a parameter, we find

$$\frac{R}{r} = 1 - \frac{2}{\pi}\left\{\sin^{-1} 2K + \frac{2K}{3}\sqrt{1 - 4K^2}\,(5 - 8K^2)\right\}$$

Again this correlates the springback parameter R/r with the geometric and physical problem and is universal regardless of material, sizes, radii, and so forth.

Since most spring materials are hardened they do not exhibit a distinct physical yield point. During spring coiling a very high stress beyond the yield point is reached in the extreme fibers. Best correlation between experimental data and the final equation is found when the ultimate tensile strength is used for the term S_y. Thus for this particular application we will set $S_y = S$.

Fig. 2 shows a typical stress-strain diagram for music wire from which it can be seen that the bulk of the permanent set that is achieved during the coil-winding operation takes place at or very near the ultimate strength level, which demonstrates the validity of this choice.

During the various tests, no attention was paid to wire tension during coiling. As indicated above, the stress levels required to perform the bending during coiling are very high—close to or equal to the ultimate strength—thus the relatively small tension stresses during coiling are probably not important.

The theoretical curve together with test data is shown in Fig. 3. It is evident that a simple straight line will represent these data quite well. This adds greatly to convenience of calculating while not causing results to deteriorate. The equation of this line is

$$\frac{R}{r} = 1.02 - 3.7K$$

This can be rewritten in terms more convenient to measure as

$$\frac{D_a}{d} = \frac{1.02}{\dfrac{1}{\dfrac{D_s}{d} - 1} + 1.85\,\dfrac{S}{E}} - 1$$

This equation can be translated to a working chart of curves as shown in Fig. 4. From this, the proper arbor size can be conveniently determined using handbook data and material specifications for S and E.

The data in Fig. 3 are purposely limited to values of D_s/d between 4 and 30 and $S/E \times 1000$ between 6 and

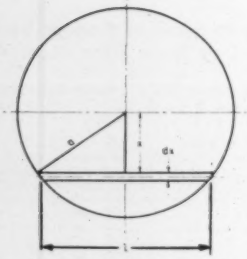

Fig. 1 Cross section of wire showing the location of measurements used in the theoretical development

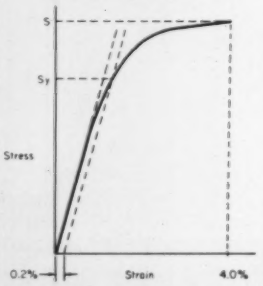

Fig. 2 Typical stress-strain diagram for music wire

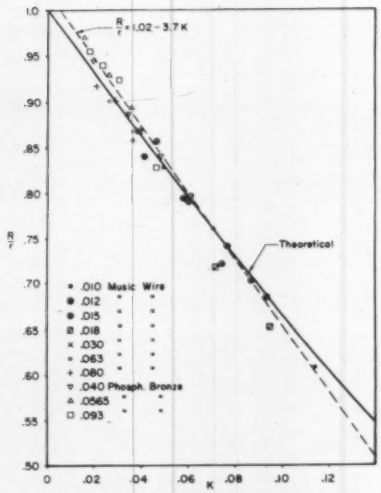

Fig. 3 Theoretical curve representing test data as a single straight line for the springback of coil springs

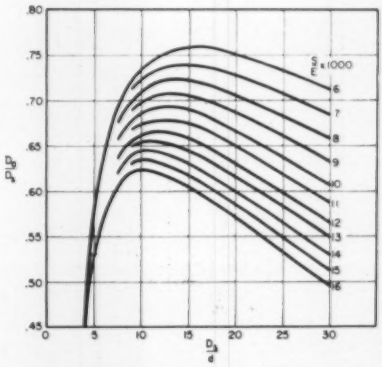

Fig. 4 Working chart of curves from which the proper arbor size can be conveniently determined using handbook data and material specifications for S and E. (D_a = arbor diam, D_s = OD of spring, d = wire diam, E = modulus of elasticity, S = ultimate strength)

16. These curves should not be extrapolated without additional tests. The authors hope the curves and tables cover a sufficiently wide range for general use. Based on the good correlation in Fig. 3 and previous experience, it is believed that a wide variety of wire sizes and other spring materials will follow essentially the same laws over the values of D_a/d and S/E given above. Only the above ratios were found to be important, thus the values of D_a, d, and so forth, are independent, and the results presented apply equally well to very large or very small spring diameters.

Use of Curves and Tables

The chart of curves, Fig. 4, can be used to determine the required arbor diameter for any type of material in the following manner: (*a*) The selection of the proper curve to be used is determined by solving the equation $1000\ S/E$. The value of S can be calculated by dividing the breaking load BL, which usually is shown on the tag attached to each bundle of wire, by the area of the wire: $S = BL/0.7854d^2$. The values of E, Young's modulus, may be taken from specifications. (*b*) Calculate the spring index, D_a/d: (desired spring OD/wire diameter). (*c*) From the intersection of the curve and the spring index, a constant D_a/D_s is found: (arbor diameter/desired spring OD). (*d*) Multiply the desired OD of the spring by the constant D_a/D_s to obtain the required arbor diameter.

The tables in this paper were prepared after determining that the great majority of springs in industry are made from music wire between 0.008 and 0.125 in. diam with spring diameters of $^1/_{16}$ to 2 in. Since the tables contain sufficient descriptive data, no additional explanation is needed.

For springs made from other materials, similar tables can be prepared from the data included in Fig. 4.

Tests

In order to prove the analysis and to check the accuracy of the curves and other data, a large number of test springs were coiled from 0.010, 0.012, 0.015, 0.018, 0.030, 0.063, and 0.080-in-diam music wire and from 0.040, 0.0565, and 0.093-in-diam phosphor-bronze wire.

The test springs were coiled over the following exact arbor diameters: $^1/_{16}$, $^3/_{32}$, $^1/_8$, $^5/_{32}$, $^3/_{16}$, $^1/_4$, $^3/_8$, and $^1/_2$ in. The outside diameters of these springs were carefully and accurately measured by a micrometer and they were found to coincide with the predicted diameters within 0.002 to 0.005 in. The average error in determining arbor size is less than 2 per cent and none has been larger than 4 per cent. The authors believe that this slight residual error is associated with material variations in size, out-of-roundness, and tensile strength, which cannot readily be reduced.

Conclusions

(*a*) The authors have arrived at a convenient method for determining the springback of hardened spring materials when coiled around an arbor.

(*b*) With the aid of the formulas and curves and by using the tables where applicable, design engineers and springmakers can determine the correct arbor diameter to obtain a specified spring diameter for any spring material.

(*c*) By determining the correct arbor diameter in advance, a considerable saving in manufacturing time occurs, and the nuisance time of trial-and-error methods can either be eliminated or considerably reduced.

(*d*) The tables will be especially useful in small-order departments of spring-manufacturing companies, in tool-and-die shops, machine shops, and experimental departments.

JOB-SHOP Challenges

Materials-Handling Systems

The Daily Problem

3000 types
2 to 300 of each
5 to 20 operations
18,000 stock parts

By J. R. Mandel

Manufacturing Systems Engineering,
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THE Merrimack Valley Works, Western Electric Company, produces telephone carrier equipment for the Bell System in a plant which will total about 1,400,000 sq ft when fully completed, approximately 300,000 sq ft of which are used for the production of small electronic components and their associated parts.

Several thousand different types of inductors, capacitors, resistors, and their parts are produced in this area.

The electronic components are manufactured in lots varying from several hundred a day to two or three per month, with an average lot size of about 50. There are usually 3000 or so different types running in the components shops at any given time, with from 5 to 20 manufacturing operations involved in the manufacture of each component. The average number of operations per unit is 12. The product made from month to month is subject to considerable variation, since the introduction of new designs, changes to existing designs, and changes in production output have to be introduced into the production operations with a minimum of delay. The parts required for component manufacture are drawn from a storeroom which stocks approximately 18,000 different parts. The parts in this storeroom are obtained from other company locations, purchased from commercial suppliers or made in the plant's parts shop. The latter produces about 15,000 different parts used in electronic components and carrier equipment, with an average of five operations per part. This shop is supplied by a raw-material storeroom consisting mainly of items purchased outside the plant, such as sheet brass, sheet copper and steel, roll stock of various kinds, rod stock, and the like.

Contributed by the Materials Handling Division and presented at the Fall Meeting, Hartford, Conn., September 22–25, 1957, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from ASME Paper No. 57—F-27, originally entitled, "Materials-Handling System for Job-Shop Production Control."

Production Problems

The many types of product and the low volume of output on any given type, plus the continually changing product pattern, created some major problems. In order to cut the number of machine setups and keep people on the same operation as long as possible, the tendency was to build up a large inventory of in-process work, ahead of each type of operation, to allow the selection of jobs requiring similar operations.

This led to a long manufacturing interval, and relatively uncontrolled process-inventory type of work-load balancing led to an excessive number of parts shortages.

In order to decide on the type of manufacturing system to be installed, two basic assumptions were made. Straight-line production alone would not be flexible enough to keep up with the frequent changes in product. Any system used, however, should be able to include, effectively, small progressive lines where the volume of production might show them to be economically justified. A mechanical-handling system should replace the maze of hand trucks, skids, electric trucks, and floor-stored in-process items in the manufacturing shops. Each basic area was the subject of an extensive engineering study.

Parts-Manufacturing Area

The problem in this area was primarily one of space and flow. The old method of delivering work to the various operations by the skid load resulted in mixed lots on skids which caused continual rehandling, and the long manufacturing interval already mentioned. Large areas were allocated as drop spaces, without steady work flow into and out of these areas. Effort was wasted in allocation of work to machines and in locating jobs in process.

In order to correct these conditions, it should be possi-

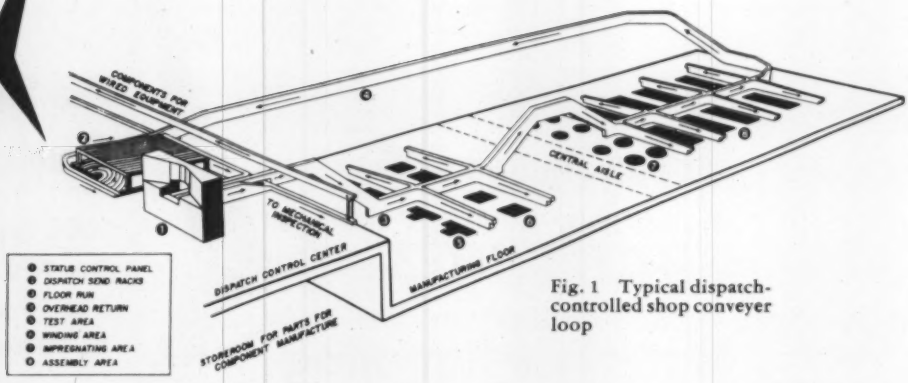

Fig. 1 Typical dispatch-controlled shop conveyer loop

ble to deliver parts from any operation to the next operation quickly and with a minimum of handling, regardless of the physical location of the next operation. The system should be so designed that individual lots can be handled economically as identifiable units, without being combined with other lots at any operation. Set-up time should be minimized and machine loads quickly balanced. It must be possible to feed back information as to the exact status and location of each lot to a central information point. The system should conserve floor space, minimize the use of skids, reduce the size of drop areas, and cut down the number of permanently installed work positions around machines. It should be possible to use the carrier or transporting device as a work surface in the machine areas.

The system selected as best fitting the list of requirements was an overhead dragline system with automatic discharge of the dragline trucks. An overhead chain conveyer pulls trucks along the floor by means of a towing mast on each truck. The conveyer runs as a continuous loop the full 450-ft length of the parts-manufacturing area with automatic discharge spurs at each major machine location such as punch-press area, screw-machine areas, and the like.

The truck can be put on the dragline at any point, routed to any selected area and automatically received in that area. The dragline trucks are so designed that the capacity of each truck is only slightly more than the average order lot, preserving the identity of the order through its various operations. No handling of the individual pans of work is required between delivery point in the work area and the machine, since the dragline truck is moved into position at the machine and used as a worktable. Immediately upon completion of each operation, the truck is placed back on the dragline, flagged for automatic delivery to the next operation shown on the method of manufacturing sheet. Thus there is no build-up of storage of completed parts in the area, lengthening of interval, or confusion resulting from split lots. Drawings and method of manufacturing sheets are included with the order on each truck as it is put into the manufacturing cycle. As each operation on the sheet is completed, that section of the sheet is detached and sent back to the central control area so that the exact status of the order may be recorded and a check maintained on the progress of the parts against schedule dates. Revisions in schedule, cancellations, short-interval orders, and manufacturing difficulties can be adjusted immediately from this control location. Delivery of tools and fixtures is also accomplished by means of these dragline trucks from a central toolroom. The final stop on the dragline for each item is the inspection area. After inspection, the majority of the parts are delivered to the component-parts storeroom.

Parts Storeroom for Electronic Components

The problem in the storeroom was twofold. The space used was excessive because of large trucking aisles and drop areas, poor utilization of overhead space, and allocation of fixed areas for parts with the size of the area being based on peak-ordering levels. Heavy expenditure of time and effort was involved in keeping up-to-date storage and inventory records by manual methods. A mezzanine-type storeroom serviced by a continuous-belt conveyer and run on the basis of dispatch control, with all entries and withdrawals handled by a punched-card system, was the solution. All material should flow through the storeroom at a minimum of cost. Mechanical handling, tabulating equipment, and a controlled dispatch system were combined with the following results:

1 A perpetual inventory record.
2 The complete control of stores activities at one point.
3 Full utilization of storage space.
4 A decrease in receiving and selecting effort.
5 A reduction of the volume and variety of paper work entering, leaving, and within the storeroom.

The stores area is largely rack-type storage consisting of a main floor and a mezzanine. Both levels are serviced by a continuous belt, with 15 gravity spurs to serve each of the 15 storage bays, an additional five spurs serving the four shop-dispatch areas, and the stores dispatcher. Material enters the storage area by means of an input spur which is controlled by the stores dispatcher. A visual signal indicates a tray or trays on each spur, while an audible signal denotes a fully loaded spur. Material of similar parts classification is stored in each of the assigned storage bays with three of the 15 bays reserved for temporary "overflow."

All material entering or leaving the storeroom is associated with a punched tab card. The manufacturing area in which electronic components are manufactured is divided into four separate shops, each controlled by its own shop-dispatch center. The weekly requirements for each of the four manufacturing areas are bulked by part

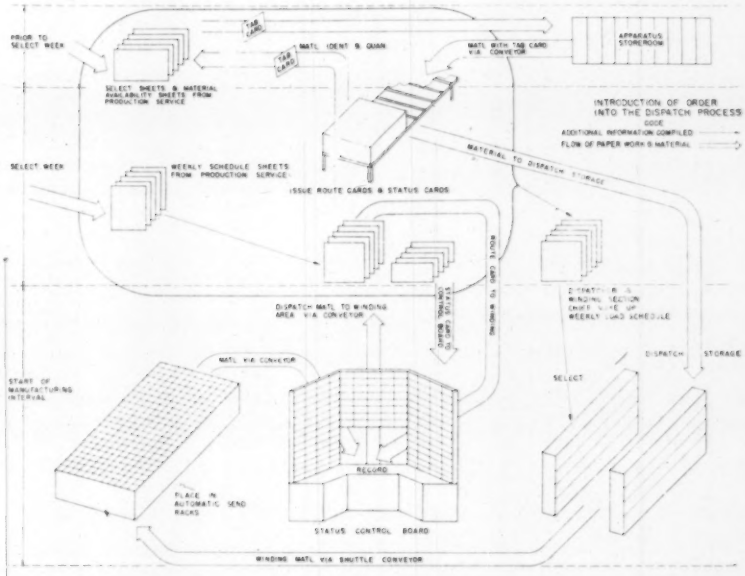
PRIOR TO SELECT WEEK
TAB CARD
MATL IDENT & QUAN
MATL WITH TAB CARD VIA CONVEYOR
APPARATUS STOREROOM
SELECT SHEETS & MATERIAL AVAILABILITY SHEETS FROM PRODUCTION SERVICE
INTRODUCTION OF ORDER INTO THE DISPATCH PROCESS
ADDITIONAL INFORMATION COMPILED
FLOW OF PAPER WORK & MATERIAL
SELECT WEEK
WEEKLY SCHEDULE SHEETS FROM PRODUCTION SERVICE
MATERIAL TO DISPATCH STORAGE
ISSUE ROUTE CARDS & STATUS CARDS
DISPATCH MATL TO WINDING AREA VIA CONVEYOR
DISPATCH STORAGE
SELECT
START OF MANUFACTURING INTERVAL
MATL VIA CONVEYOR
RECORD
PLACE IN AUTOMATIC SEND RACKS
STATUS CONTROL BOARD
WINDING MATL VIA SHUTTLE CONVEYOR

Fig. 2 Flow chart, showing the flow of a pan of parts through the dispatch area which is located on the mezzanine deck of the storeroom, providing the dual advantage of simplifying the mechanical problems, and providing an elevated vantage point

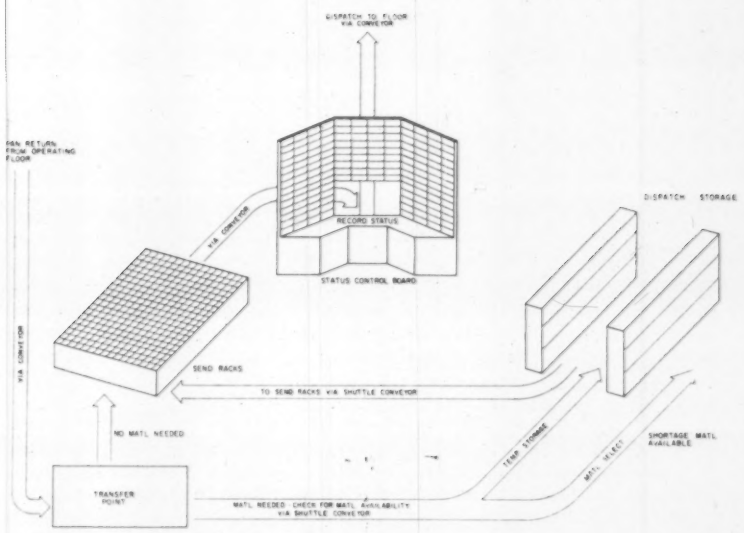

Fig. 3 The work flow within the dispatch area, once the manufacturing process has started. The pan travels to the various areas for addition of parts and dispatch to the floor conveyer when parts have been assembled.

number and a tab card cut for the total weekly requirements of each shop, one card per part. These cards are delivered to the stores dispatcher who then uses them as select cards. These select cards are marked with the spur number by which the item to be selected is located, and with the number of the shop dispatch area to which parts are to be delivered. Two key-punch machines are located in the stores office, and a punched card is cut for each bulk entry into the stores area, similar to the withdrawal card. The receival and select tab cards are used for the following functions:

Mechanical wage-incentive accounting.
Mechanical inventory report.
Mechanical daily-shortage report.

The storeroom is operated under a dispatch-control system. All paper work and records are handled from this central location, and all decisions regarding storage locations of new items, inventory adjustments, changes in storage-space allocations, and handling of shortage items are made here. The material handlers working in the storage area itself are concerned only with the physical operation of placing material in racks as it is received on the work spurs, or selecting material from the racks in accordance with the tab-card requests. The size of the labor group depends solely on the weekly number of selects and receivals rather than the number of assigned-storage locations, and allows complete freedom in shifting effort as the load varies.

Selected material from this area is fed via conveyer belt

to the shop-dispatch area controlling the actual manufacturing of electronic components.

Component-Manufacturing Area

The component-manufacturing area was the most difficult of all. Good production control was important for meeting schedules in the subsequent assembly and wiring of finished carrier equipment. The component shops were split into four separate self-contained areas, each serviced by a conveyer controlled by a dispatch center. The heart of this system is the dispatch-control center where full control of the shop operations, inventories, schedules, and materials is located.

Since the base on which this handling system for production-control electronic-component manufacturing is founded is the principle of dispatch control, the conveyer system and associated control equipment are designed to simplify and make more automatic the dispatching operation. Fig. 1 shows a single shop-conveyer loop and dispatch-control center indicating some of the "hardware" involved in this installation. The actual manufacturing area for components exclusive of the storeroom is approximately 90,000 sq ft, with an additional 19,000 sq ft devoted to dispatch control and in-process storage.

Each of the four manufacturing units is divided roughly into functional operational areas; for instance, winding, impregnating, process testing, magnetic-material assembly, wired assembly, mechanical assembly, and the like. Each of these functional areas is serviced by a spur off the main belt loop. The dispatch area itself, which services these spurs, consists basically of an automatic send rack and a dispatch-control board.

Material is handled throughout the process in special conveyer pans, which may be pinned to deliver automatically to any of the spurs. The send racks are provided with an automatic-cycling device which allows a pan to be delivered from each feeder in the send rack automatically, in numerical sequence. Each floor spur is electrically connected to the corresponding feeder sections in the send rack so that, whenever a spur is fully loaded, the send cycle is omitted on that feeder until pans have been removed from the spur.

When pans are sent out through the send racks, they arrive at the dispatch-control board which contains all the control equipment for the conveyer belt and the control for the shop intercom system. Racks of status cards provide a check on the location and stage of completion of every pan of in-process work in the shop. Route cards accompany each pan of work through the various stages of manufacture. These route cards are actually a combination method-of-manufacturing sheet and results record. The information listed on the card provides a comprehensive record of the progress through the shop, with regard to both time and quality of the manufacturing operation. Since the work is returned through the dispatch center each time an additional spur location is shown on the card, the dispatcher is able to control his quality, work load, and schedule dates directly from the information flowing through his position via these route cards. If parts must be added to the pan before the next operation, the pan is sent to the "select" area via a gravity conveyer section.

When pans of work for which parts must be selected appear on the gravity conveyer in the select area, a check is made against the material availability record to pick up storage items, the pan is routed either to select or hold areas, depending on parts availability, and the location is noted on the status board. This procedure continues until the manufacturing operations on the components being manufactured are completed. The final inspection operation on all components is in a separate area serviced by the conveyer network. Here, as rapidly as inspection operations are completed, the components are placed on the conveyer belt for delivery to an equipment-storage area ready for assembly and wiring into equipment.

The dispatch operation, as described in the general flow of work, requires considerable co-ordination of paper work with material flow. Fig. 2 gives a flow picture of the time, paper, and material flow required to introduce an order into the dispatch process, while Fig. 3 provides a picture of the work flow within the dispatch area once the manufacturing process has started.

Experience with this system, both with the new installations at Merrimack Valley and with information gained from a trial system at the Haverhill Western Electric location, which has been in operation several years, has convinced us that the system would be justified economically alone for the control of quality and reliable data on damaged-merchandise losses which it provides. In addition, it provides an easily supervised control mechanism; a balanced work load which is easier to maintain, control, and evaluate; and a perpetual, easily accessible check on inventory. Manufacturing and engineering difficulties can be picked up and pinpointed directly from the control center without the need of exhaustive surveys, manufacture of control lots, and similar methods. Supervisors have more time available for training personnel and personnel relations.

Summary

The operation of this plant has been planned from start to finish with material handling as an aid to control of production a primary objective. The portions of the plant described in this paper are the most extensively mechanized, but the over-all plan has also been carried through all areas, with a dragline system in the carrier storeroom, conveyers for organic and inorganic finishing, and straight-line progressive assembly of components and equipment planned where the volume justifies such arrangements. It is realized that much work remains to be done before full realization of the potential of this basic system will be complete. However, the capital investment items which constitute the handling system itself, together with the basic system, are flexible enough in concept and application to take the normal changes in production methods, levels, and designs. Additional features, many of which are now under study, will enhance the value of the basic system. In fact, many advances in the use of tabulating equipment and computers, more general use of sampling inspection procedures, and automation of general type operations will be possible because of the framework which has been provided.

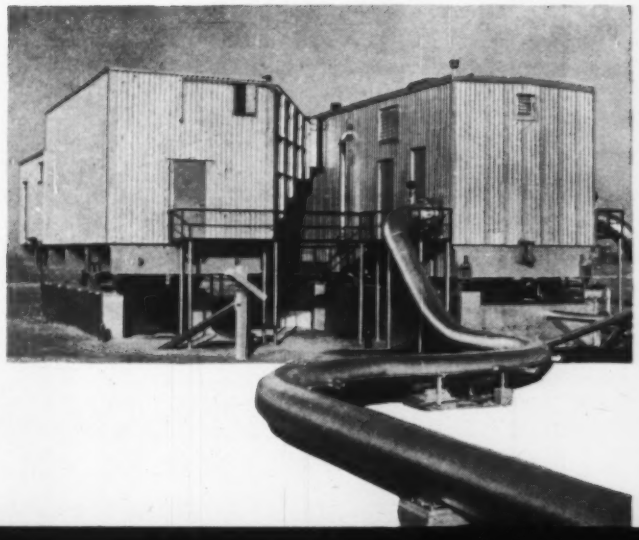

Fig. 1 Control van *left*, and turbine van of an unattended pumping unit. Tapline reports on 10,000 hr of operation.

No men within 50 miles: But Tapline's portable, radio-controlled, gas-turbine pumping units move oil across Saudi Arabia. The investment: One sixth that of a community-type station in that barren desert.

GAS TURBINES in the Arabian Desert

By W. E. Locher,[1] A. E. Olson,[2] and P. P. Nibley,[3] Mem. ASME

Trans-Arabian Pipe Line Company, Beirut, Lebanon, and New York

THE Trans-Arabian Pipe Line Company has placed into operation six new pumping units driven by 5000-hp General Electric combustion gas turbines. These units, together with the original pumping equipment driven by diesel engines, provide the power to move 450,000 bbl per day of crude oil a distance of 754 miles through a 30–31-in. pipeline from Qaisumah, Saudi Arabia, to a tanker-loading terminal on the Mediterranean coast near Sidon, Lebanon.

The new units are of two types: Portable prefabricated units for unattended operation at intermediate sites; and permanently installed units at existing stations. Fig. 1 shows the turbine van and the control van of a portable unit (known as an auxiliary) as installed for operation. The Trans-Arabian system has three of these unattended units, while the Arabian American Oil Company (Aramco) has two similar units on its 270-mile line feeding crude oil into the Tapline facilities at Qaisumah.

Original System

The original Tapline system, as completed in December, 1950, had four diesel-engine-driven pumping stations spaced about 160 miles apart, which provided an initial capacity of 320,000 bbl per day. Each of these main stations is a complete community in the vast and barren Arabian desert. The desert climate is characterized by extremely low rainfall and by summer temperatures reaching 120 F and winter temperatures dropping to 30 F.

Each community installation includes housing for 80 to 250 employees, a community center with a dining hall, commissary, and recreational facilities, warehouses.

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[2] Chief Field Engineer and Manager of Construction, Beirut.
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Contributed by the Gas Turbine Power Division and presented at the Gas Turbine Power Conference and Exhibit, Washington, D. C., March 2–6, 1958, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. ASME Paper No. 58—GTP-8.

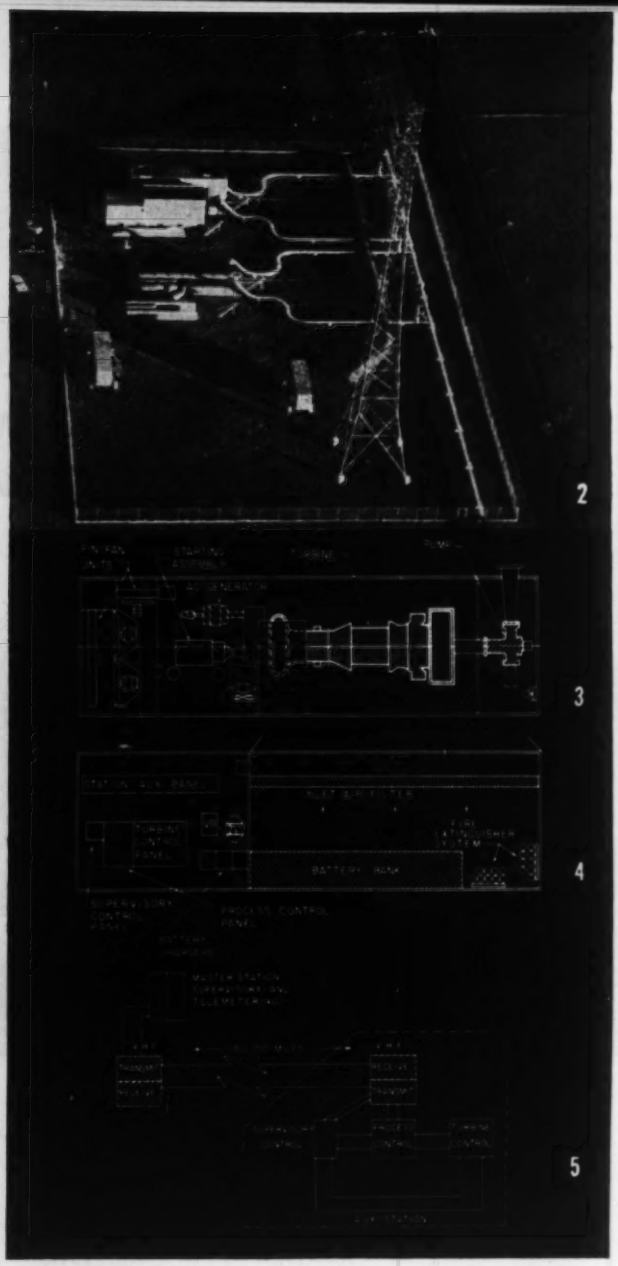


Fig. 2 Typical unattended pumping unit: Turbine van, control van, radio van (with permanent, 200-ft-high antenna tower), and portable shop van. Tapline has three of these units, Aramco two, with one standby. Cost is one sixth that of the miniature city required for a permanent, manned station.

Fig. 3 The turbine van, 53 ft long, 15 ft wide, 18 ft high, weighing 125 tons. Turbine room and pump room are separated by a fire wall. The turbine burns crude oil taken from the pipeline.

Fig. 4 Control filter van. Control room contains the basic panels. Like the turbine room, it is operated at a slight positive pressure to exclude dust and petroleum vapors.

Fig. 5 Schematic routing of a control signal initiated from the master supervisory control panel located 50 to 100 miles from the operating unit. The all-relay, space-code selector system provides the means for starting and stopping the turbine by remote control, for changing discharge pressure, and for receiving alarms covering important functions.

garage, shops, and hospital, as well as the main pumphouse and oil-handling facilities. Each station has its own water supply and complete utility system. Water is available only from wells, some of which are over 1000 ft deep.

The pipeline was initially constructed to accommodate four additional pump stations at intermediate locations. However, the large investment and relatively high operating costs of complete community stations made this type economically unattractive.

The Unattended Unit

The most attractive scheme to increase capacity involved the installation of one 5000-hp unattended pumping unit at each intermediate location. The simple-cycle combustion gas turbine was the only prime mover which satisfied the unique design requirements for these auxiliary units. The requirements were:

1 5000-hp[4] output for continuous operation at 110 F ambient temperature and 2600-ft elevation.

2 Prime mover to be fueled with crude oil taken directly from the pipeline.

3 Unit to be suitable for unattended operation with supervisory control from base stations 50 to 100 miles away.

4 Unit to be portable to permit rotation and major overhauls at a central shop.

The International General Electric Company was the

[4] Average annual output, 6000 bhp.

successful bidder for supplying both the auxiliary pumping units and the permanently mounted turbines for the base stations. The auxiliary pumping units were completely prefabricated and factory-tested in the United States. They were then shipped to Saudi Arabia, hauled overland to the job site, slid onto concrete foundations, and connected to pump oil. The major work of installation was completed by Jan. 1, 1958.

This is the first time that a main-line oil pump has been driven directly at gas-turbine speeds; the speed range of 5000–6000 rpm is considerably higher than that commonly used for oil pumps. This is the first time that a complete 5000-hp pumping unit has been prefabricated and made wholly portable. Also, this is the first time that a gas-turbine pumping unit has been operated unattended and by remote control.

Investment per Horsepower

Fig. 2 shows an unattended unit. A comparison of the extensive facilities at a typical diesel station (a miniature city) with the minimum facilities at an unattended unit presents a vivid contrast. Yet the hydraulic horsepower delivered to the pipeline by either installation is the same.

The installed cost of an unattended unit, including the communication and portable-shop installations, is about $1.5 million, or $250 per bhp on the basis of an expected annual average output of 6000 bhp. This is one sixth the investment per horsepower of a conventional community-type station in Saudi Arabia.

Turbine Van

Fig. 3 shows a simplified plan view of the turbine van. The gas turbine is a two-shaft simple-cycle unit, rated at 5000-hp shaft output at 110 F and 2600-ft altitude, and it burns crude oil taken from the pipeline. An aqueous solution of a corrosion-reducing additive, magnesium sulfate, is blended into the crude at the turbine. The crude oil contains about 10 ppm of vanadium and requires an addition of 0.03 per cent by weight of hydrous magnesium sulfate to minimize corrosion of the turbine blades. The additive system is contained within the turbine and control vans and is automatically co-ordinated with the fuel requirements.

The turbine is started by a 200-hp diesel engine with torque converter drive. The engine is coupled to the gas turbine through a jaw-type clutch which automatically disengages when the turbine reaches self-sustaining speed.

The main crude-oil pump is driven directly at gas-turbine speed (5000–6000 rpm). The pump was manufactured by Byron Jackson Pumps, Inc., and is an extremely compact unit, with an over-all length of 5 ft-1 in., max width of 4 ft, max height of 4 ft, and weight of 4650 lb. The pump has the unique features of weighing less than 0.8 lb per bhp and delivering more than 600 psi differential with a single-stage impeller.

The turbine, in addition to driving the main crude pump from the load turbine shaft, also drives a 125-kva generator from the compressor shaft. This generator supplies electric power for the entire auxiliary pumping unit when the gas turbine is operating.

The temperature of the cooling water for the gas-turbine lube-oil system and critical parts of the turbine is automatically maintained by circulating the water through two fin-fan units. Air is circulated through these units by two fans driven by 20-hp a-c motors. During cool-down of the unit, an auxiliary 5 hp d-c fin-fan cooler is used.

Control Van

Fig. 4 shows a simplified plan view of the control-filter van. The section of the enclosure containing the inlet air filter is open on top to admit air to pass through the filter for the gas turbine and for ventilation of the turbine and control rooms.

Mounted in the control room is the auxiliary panel which contains the electrical switchgear, motor starters, and control relays. Also mounted in this room are the turbine control panel, process control panel, and remote supervisory control panel, as well as the voltage regulator and battery chargers. Located between the battery chargers and voltage regulator is a 10-kva inverter used to supply constant frequency a-c power to some of the instruments and to supply the basic power for the communication system.

Shop Van

The portable shop van is divided into two sections. One is a shop and parts-storage area equipped with power tools. The other is a personnel locker-room area, equipped with an electric kitchen and a washroom for use by maintenance personnel.

Radio Van

The radio van contains the vhf radio transmitters and receivers and a 30-kw auxiliary diesel-generator set. There are three 250-watt, 150-megacycle, fm transmitters in each van; two transmitters are for voice, telemetering, and supervisory equipment, and the third is for mobile-equipment communication. The system employs scatter propagation and utilizes extremely high-gain antenna arrays mounted on 200-ft-high towers.

The auxiliary generator starts automatically when the gas turbine shuts down, and supplies power to the 208-volt bus to maintain lights, communication, essential services, and a charge on the 800-amp-hr battery bank. If the auxiliary diesel-generator set is temporarily out of service, the station battery, fully charged, is capable of supplying electric power for three complete start-ups and shutdowns of the gas turbine.

Control System

Fig. 5 shows the schematic routing of a control signal. In addition to the supervisory control, there are four telemeter functions; namely, ambient temperature, discharge pressure, and suction pressure at the unit, and discharge pressure set point which is the basic control function. Each of these four telemeter functions is continuous. The supervisory and telemetering information is simultaneously carried on two independent vhf circuits. Two circuits are provided to avoid an interruption of contact between the master station and the operating station in case one of the circuits fails. It also allows the use of diversity reception, which greatly improves the reliability of the system.

The basic functions required for controlling the turbine are the start and stop selector keys, the raise-and-lower set-point selector keys, and the selector keys con-

nected to the voice-communication channel, which initiate contact so that a microphone in either the pump room or the turbine room of the operating unit can be heard at the master station.

Located on the master supervisory panel are three groups of lights indicating first, second, and third-order alarm groups. First-order alarms are serious enough that the turbine unit is tripped, and a trained technician should go to the station before restarting the unit. Other alarms may not cause tripping of the unit but, if they do, it is safe to restart the unit by remote control before the technician goes to the station to investigate.

Remote Control

For the start-up and operation of the unit by remote control, the operator at the master supervisory control first checks to make sure that the panel is clear of alarms and in remote-start position. He then depresses the "start" selector key. This action sends a signal to the turbine control panel which in turn sends a signal to the motor-starter panel to start the d-c motors of the auxiliary fans and pumps required for commencing operations. The main-line gate valves also open, pressurizing the main crude-oil pump.

After a five-minute interval required for purging the turbine van with the d-c purge fan, the starting diesel is automatically started, the clutch is engaged, and the turbine is accelerated to firing speed. After the turbine is fired, it is further accelerated to idling speed. During the acceleration, the breaker for the a-c shaft-driven generator is closed; the a-c station motors are started in preset sequence and the d-c motors are shut down.

After that, a signal is sent back to the master control panel, indicating that the starting sequence has been completed. The entire sequence of operation is automatic once the operator depresses the start key.

The unit now is ready for adjustment of discharge-pressure set point. This set point is controlled by the operator, who depresses the raise-or-lower set-point selector keys as required. Once a set point has been established, the process control automatically maintains the required pump speed to maintain this discharge pressure.

Process Control

The process system basically compares a pneumatic pressure established by a transmitter (which converts a process pressure to a pneumatic pressure signal) with an established pneumatic pressure which is a function of the desired process pressure (set point). If there is a difference in these readings, an "error" signal is sent to the turbine control to increase or decrease turbine speed accordingly.

In addition to the basic controls, there are overriding features which limit the rate of change of pressure and which limit the min suction and max discharge pressures to prevent damage to the pump or pipeline.

Permanent, Manned Units

The installation of two 5000-hp turbine pumping units at the permanent pump station at Turaif, Saudi Arabia, follows a more conventional pattern with the exception of a unique suction booster pump. When both turbines are in operation, an excess of hydraulic horsepower is available. Part of this horsepower is utilized to operate a hydraulic turbine-driven booster pump to provide a suction pressure of 60 to 90 psig for the main pumps. The hydraulic-driven pump was supplied as a package unit by Byron Jackson Pumps, Inc.

Operation and Maintenance

Up to Jan. 1, 1958, Aramco and Tapline had operated the gas-turbine pumping units for a total of approximately 10,000 hr. Most of these operations were carried out with personnel in attendance, many of whom were present only for possible emergencies or to record pertinent data from nonrecording instruments. One of the auxiliary pumping units has had several months of unattended operation, with an availability factor of better than 90 per cent. Another was successfully operated unattended after a trial run of only 80 hr.

Two of the auxiliary-pumping unit turbines have been disassembled at their regular locations, to make adjustments to main bearings and seals. A crane was moved to the turbine van and, after the removal of sections of the roof, parts of the turbine were removed and laid on a canvas on the ground outside, and protected by a canvas covering. Although dust storms occurred at frequent intervals, it was possible to do all the necessary work and make final adjustments during periods of clear weather. Such work can only be accomplished by a crew of men trained to work under adverse conditions.

Those parts which required machine-shop work were moved either by automotive equipment or by aircraft to and from the central machine shop at Turaif. This shop is equipped with a dynamic balancer, a test stand specifically designed for the turbine-control and auxiliary equipment; and the necessary machine-shop equipment to handle all parts.

Tapline plans to haul each turbine van to the central shop at Turaif for major overhauls. During these occasions the spare turbine van will be installed for temporary operation at the intermediate location.

Future Application

Preliminary operating experience indicates that the auxiliary pumping units will have a high degree of reliability and a relatively low operating cost, despite a fuel consumption per hp-hr approximately twice that of the originally installed diesel engines. Tapline is convinced that it has a well-designed pumping unit which can be operated successfully by remote control.

The feasibility of unattended gas-turbine pumping units definitely changes the economics of pump station spacing for large-diameter pipelines in the Middle East. Because of the lower investment per horsepower, the optimum spacing for unattended pumping units will be much closer for a given pipe size than for the older, extremely expensive stations of the community type.

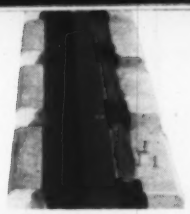
Reference

"Intermediate Gas Turbine Pumping Units of Trans-Arabian Pipe Line Company," by P. P. Nibley and A. Y. Hillman, Jr., *Electrical Engineering*, vol. 77, February, 1958, pp. 158–162.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Assistant Editor

BRIEFING THE RECORD



Interrupter blades, used to clock the speed of rocket sleds, were installed at 13-ft intervals with an accumulated error of less than 1 in. in the 7-mile length of the track. The fixture was used to position the interrupter-blade mounting studs.

Super-Straight Track

THE rails of an ultra-high-speed track, designed for testing supersonic rockets, aircraft and missile components, and supporting equipment at speeds up to Mach 4, are being aligned to within ±0.005 in. of theoretical perfection at the Air Force Missile Development Center, Holloman Air Force Base, New Mexico. According to Delta Design Engineers, Inc., the San Diego, Calif., engineering firm responsible for aligning the track, the requirements were so stringent that straight-line intervals as short as 100 ft could not be considered sufficiently close approximations to a great circle arc. Topographical curves within the track could not have a radius of less than 2 million ft!

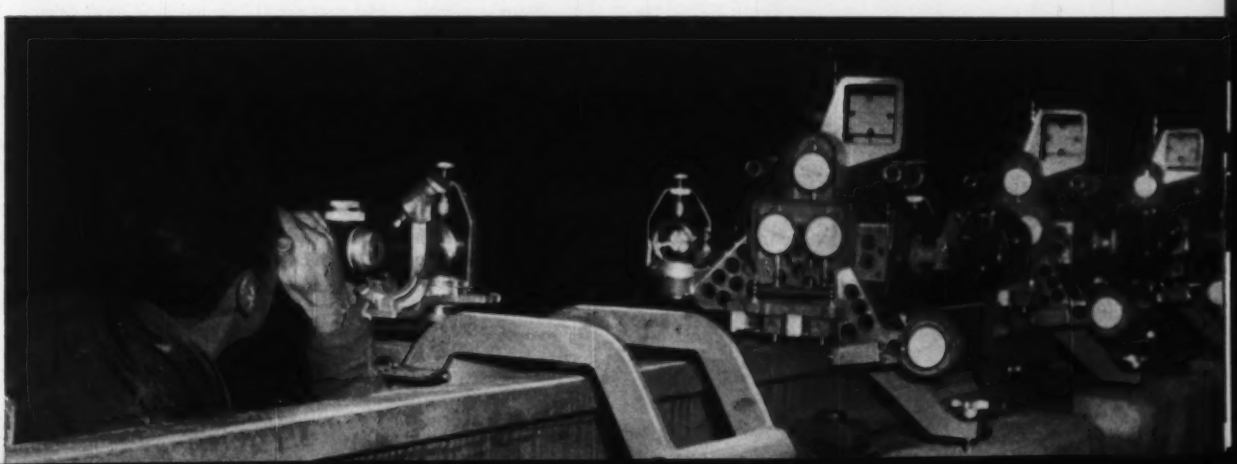
Among other unique requirements in the hair-splitting alignment were the grinding of welded track joints to within ±0.0025 in. of the adjoining rail surfaces, stretching the heavy steel track like a violin string with a 100-ton jack to nullify the effect of temperature variations, and the installation of interrupter blades—used to clock the speeds of rocket sleds—at 13-ft intervals with an accumulated error of less than 1 in. in the 7-mile length of the track.

In order to obtain a perfectly smooth surface for the rocket sled, each 2-mile section of track was welded into one continuous piece, then stretched as much as 5 ft with a powerful hydraulic jack, and, while in tension, anchored in place. Stretching was necessary to prevent buckling due to temperature changes. Thus stretched, the rails are relaxed at 120 F and under tension at temperatures below 120 F.

Delta designed and constructed a unique grinding machine for grinding the inside and outside radii and plane surfaces of all track welds. The machine employs two electric-powered belt grinders, each positioned on counterbalanced movable arms which maintain the grinder spindle precisely parallel to the track surfaces. The depth of the grinding cut is controlled by a follower on each side of the grinding head which is guided by the surface of the track.

A wide variety of special equipment was built by Delta Design Engineers for aligning the track to virtually zero error. This equipment was designed for rapid alignment of the track in progressive 100-ft intervals, utilizing pre-established U. S. Coast and Geodetic Survey markers adjacent to the track as reference points.

Sighting in the track gage during rail alignment. Operator positions track gages by remote control. Note the four fingers of the track gage which control the track while it is brought into virtually perfect alignment.



Electron Sterilization

BEAMS of electrons are in full-scale commercial use for sterilizing catgut sutures manufactured by Ethicon, a division of Johnson & Johnson. This is the first commercial use of a microwave linear accelerator for sterilization of a medical product.

The million-dollar 7-Mev electron-beam sterilization process culminates 10 years of research by teams of physicists and technicians of Ethicon and High Voltage Engineering Corporation of Cambridge, Mass., supplemented by medical and biological research. Irwin Sizer, professor of biology at M.I.T., was a consultant on the project.

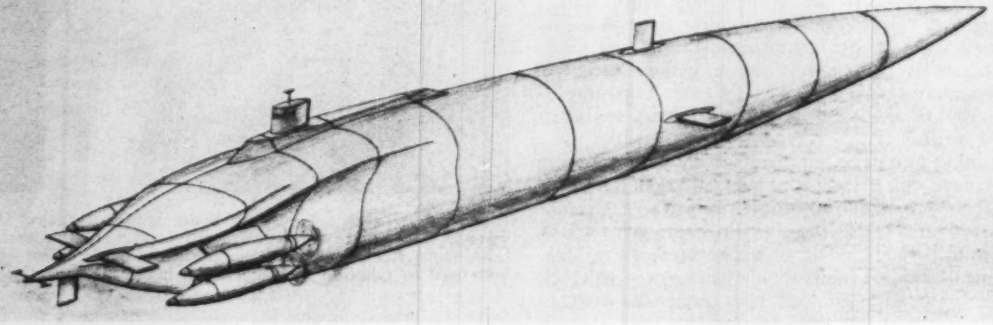
The electrons destroy all microorganisms in or on the catgut suture by altering the molecular structure of the bacteria without disturbing the structure of the suture itself.

The electron rather than the neutron or radioactive material is used in the sterilization process because it does not produce any residual radiation, nor is there any formation of radioactive by-products in the material being sterilized. Also, time is less, 5 to 7 hr being required for cobalt-60 sterilization.

Sterilization is at 3.0 million reps, more than sufficient to kill even such highly resistant spore forms of such organisms as tetanus and gas-gangrene bacteria. From 5 to 10 dozen sutures are treated per minute. Since sterilization is accomplished in sealed packages there is no danger of recontamination in handling.

Tensile strength is greater than for heat-sterilized catgut, and in animals and in human patients it has been shown that irradiated sutures have the same properties, as measured by tissue reaction, absorption, and similar factors, as have sutures that have been sterilized by conventional means.

The process control and verification of dosage are accomplished by the use of polyvinyl chloride film. A piece of the film is placed on each tray of sutures as the tray makes its way along the traveling belt to a position under the electron beam. The electron beam turns the film green. Later, the film is baked and a chart has been worked out to determine from the shades of color how much dosage has been given the suture batch.



A high-speed underwater oil tanker of about 100,000 tons total weight being developed in England and cruising at 50 to 60 knots would look something like this, according to a sketch prepared by *Engineering*

Underwater Oil Tankers?

NUCLEAR-PROPELLED submarine oil tankers are in the design stage in Japan and are the subject of preliminary studies in England, according to an article in the British journal *Engineering*.

Wave-making resistance, the principal drag on surface craft, can be drastically reduced by operation far below the surface, and there is the possibility of using a very light structure. Although hydrostatic pressure at the operating depth may be ten atmospheres or more, the shell structure would actually serve only as a surface of separation for two liquids and require very light stressing. There would be no back-breaking moments in the absence of waves, and propeller loads could probably be arranged to act in tension.

The tanker would remain under water for unloading operations, taking in water as the oil was pumped out through flexible pipelines. The crew would enter and leave via a retractable conning tower. During launching, some collapsible reinforcing structure would be required that could be removed after submersion and filling.

Since surfacing would be ruled out, communication and navigation pose some special problems. Air-conditioned living space would be severely limited, and a very small crew required. Special selection and training of crew members would be needed to withstand the psychological strain.

In Japan, Mitsubishi Heavy Industries are well along with a 33,000-ton-deadweight design that would have a submerged speed of 22 knots. In England, Mitchell Engineering, Limited, is sponsoring research on underwater-hull forms by Saunders-Roe, Limited. The experiments will determine whether the competitive economies of underwater tankers would justify backing on a national scale. Craft of the order of 100,000 tons total weight, cruising at 50 to 60 knots, are envisaged.

Eight models of various shapes will be tested by Saunders-Roe. The first six configurations have been established, and the remaining two will be based upon the optimum characteristics that have been approximated with the first six. Each model is 6 ft long, and length-to-breadth ratio varies from 7 to 14. Five are of circular cross section, and one is square. Model data will be extrapolated to full-scale Reynolds number to provide data for a range of sizes of full-scale bodies.

The propulsion system would constitute a major project in itself. Closed-cycle gas-turbine, or nuclear-derived-steam or electrical-propulsion systems are possible alternatives. An even more radical solution might

be a propulsive water jet—less efficient than turbine-and-shaft drive, but less complicated mechanically and simpler to install.

Propellers are likely to be of the narrow-blade wedge-section "supercavitating" type, since it seems fairly certain that, at the high speeds involved, the propellers will be operating in the fully cavitating regime. Friction loss for this type is much lower at the operating speed than for propellers of conventional design.

Location of the propellers may be unconventional, too. Although the pusher-type are likely to attain the maximum efficiency, they impose compressive stresses on the shell. Tractor propellers at the nose or clusters of podded pusher propellers amidships are alternatives.

Clutch Laboratory

A NUMBER of new testing devices especially designed by Formsprag Company engineers are installed in the Warren, Mich., company's 100 per cent enlargement of its laboratory facilities. These are for the testing of sprag-type overrunning clutches used in the aeronautical, automotive, and general manufacturing industries.

Among them is a novel "sprag tester," a machine that measures the gripping angle of sprags by a combination electric and mechanical arrangement. An indexing test stand tests the indexing efficiency of clutches at extremely high speeds. A pneumatic and electrically operated test stand for transmission-type clutches tests for either speed or load independently, or both simultaneously, and records the results electrically. An overrunning stand is now in use on which extremely high overrunning speeds can be obtained.

Torque load on a clutch is observed in oscilloscope. The clutch is indexing against the load supplied by a disk brake at 600 cpm.

Below, a Sprag Checker measures the geometric properties of a sprag

Standardizing Motors

AT SCHENECTADY, General Electric's "small a-c" department has a new, highly mechanized plant to produce 40 to 125-hp electric motors.

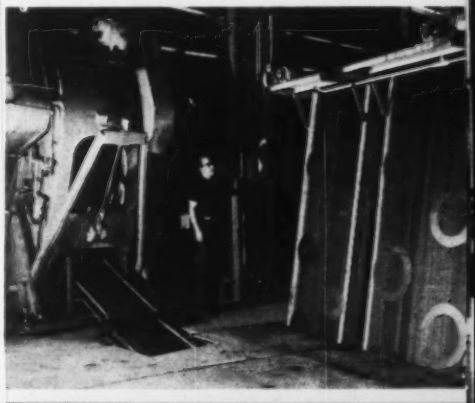
For its "Tri-Clad 55" motors, GE designed standardized parts which could be produced in volume and assembled in various combinations to meet a variety of special requirements. Although two thirds of the motors in this class are ordered as "specials," the plant can stock 80 per cent of the parts for all its production. For both standard and special motors, all parts travel in the same line during machining and assembly.

On a basic frame, GE can interchange a variety of parts, such as end shields, conduit boxes, and bearing caps. Special motors have their own process areas to which they can be shunted when they would interfere with standard motors. Result: The flexibility of the job shop with the economy of the production line. Delivery time is cut in half.

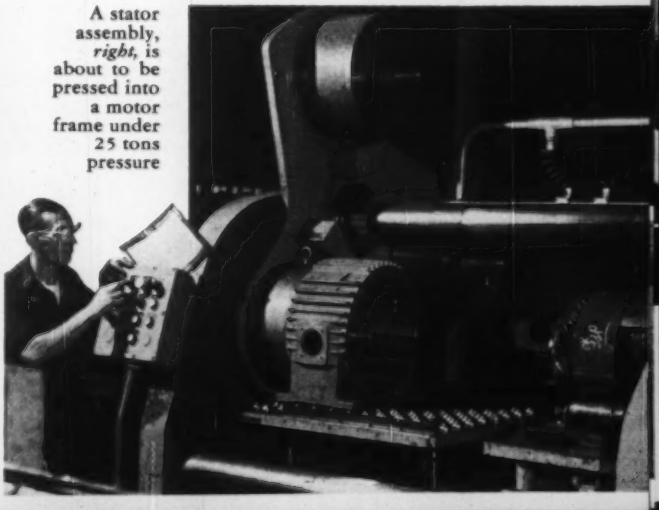
Quantity production began in July, 1957, after a team of design engineers worked for $2\frac{1}{2}$ years developing plant and product together. Standardization has permitted use of a teletype system for scheduling and sequencing parts into final assembly. This provides positive control and reduces investment in raw and process inventory.

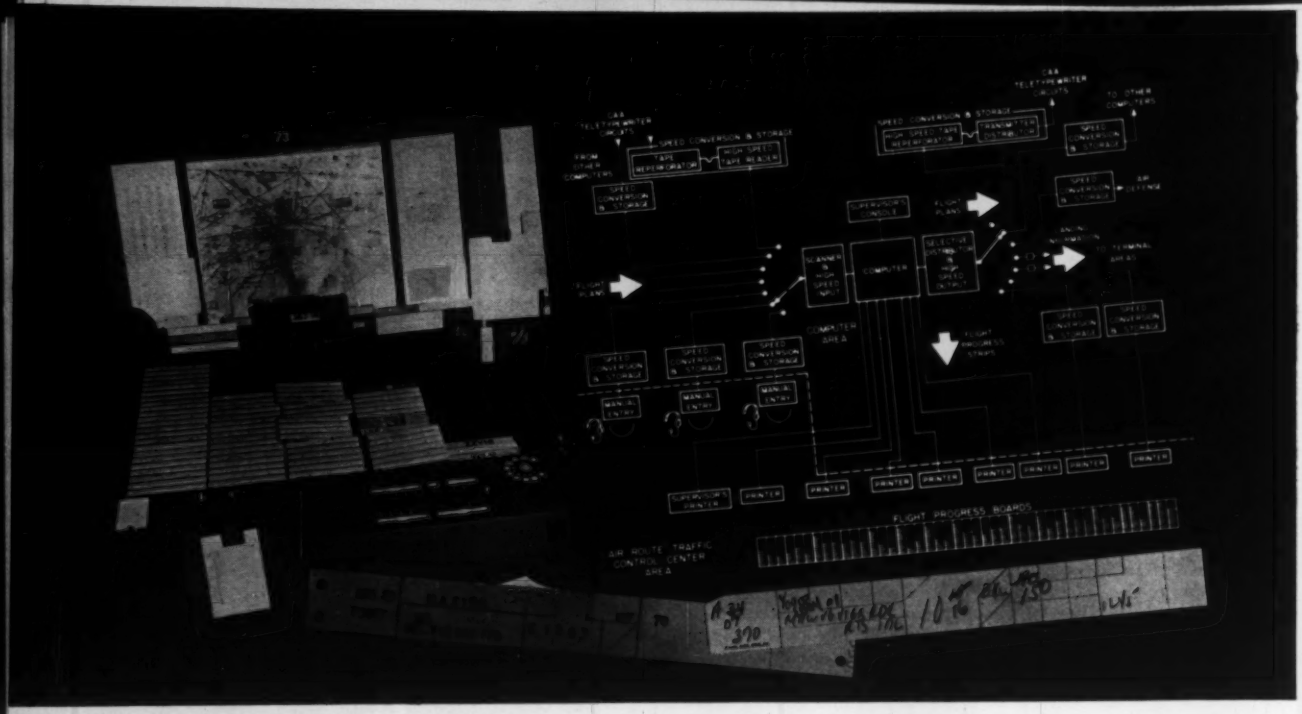
J. M. Crawford, vice-president and general manager of GE's motor and generator division, predicts a 30 per cent increase by 1961 in industry sales of electric motors and generators.

Magnetized belts carry steel rotor and stator blanks from the punch press to the indexing area



A stator assembly, *right,* is about to be pressed into a motor frame under 25 tons pressure





Basis of the new CAA system of computer control of air traffic is the flight strip. Handwritten and computer-typed versions are seen in the *lower photos.* These are accumulated on the flight-progress boards for each sector. As the *diagram* shows, the computer system breaks down the flight plan filed by the pilot, analyzes the route, and stores the information. At the appropriate time the computer will locate the flight-plan information in its memory and transmit it automatically over the communication circuit to the destination. Several channels can be served by a single high-speed output.

Computer-Controlled Air Traffic

ELECTRONIC COMPUTERS are being used at the Civil Aeronautics Administration Development Center in Indianapolis, Ind., for air-traffic-control operations. The development of the system was outlined in a paper by G. E. Fenimore on "Real-Time Data Processing for CAA Air Traffic Control," presented at the 1957 Eastern Joint Computer Conference in Washington, D. C.

Air-traffic control is exercised both in the terminal area where the plane is under the jurisdiction of the tower controller and in the en-route area. For en-route control, with which Mr. Fenimore's paper was principally concerned, there are approximately 30 air-route traffic-control centers in the continental United States. A typical center has jurisdiction over an area roughly 300 miles across.

Areas are divided into sectors for which an individual controller is responsible. A board with a tabular display of flight-progress strips is maintained. Within a sector there are several key traffic-control points, generally located at the intersection of airways, which are called "fixes." Aircraft are required to report their speed, route, altitude, time, and location as related to schedule whenever they pass over one of these fixes. From these reports and comparison with flight plans filed prior to take-off the proper separation of aircraft in time and altitude is maintained.

Traffic controllers receiving flight plans by interphone prepare punch cards which are fed into an IBM 650 computer. The computer determines the route of flight, calculates estimates, and automatically prints all the flight-progress strips required.

A prototype of the Model I Univac system for installation at the New York and Washington, D. C., traffic-control centers is now being assembled at Indianapolis for testing and evaluation.

By using an adaptation of Remington Rand's scanner and speed-conversion device from their airline-reservations systems, up to 20 communication channels operating at teletypewriter speeds can work into a single high-speed input to the computer.

The computer will analyze the route of flight, determine over which fixes the aircraft will pass, estimate the times of arrival over each fix, assemble data in the proper form for printing flight-progress strips, and transmit the data to one or more of the flight-progress-strip printers in the center area. At the same time it will keep a record of the flight plan itself and all fix data within its memory. Flight plans which enter the system from distant points over the communication lines will go directly into the computer for processing.

If a flight plan is to continue into an area served by another air-traffic control center, flight-plan data must be forwarded to that center in order that strips may be prepared. At the appropriate time, the computer will locate the flight-plan information in its memory and transmit it automatically over the communications circuit to the proper destination. A configuration of selective distributor and speed-conversion units will permit one high-speed output from the computer to serve a number of low-speed communications channels.

To permit rapid and accurate composition of flight-plan messages, a contract has been made with Aeronutronic Systems, Inc., of Glendale, Calif., for the development of flight-data-entry equipment whereby an operator may compose a message which is displayed on a cathode-ray tube and stored during composition.

If the operator makes an error he may backspace rapidly, or a character at a time, to the position where the error occurred. Having corrected the error, he may shift rapidly back to where the message composition was interrupted and continue. A form on the face of the display designates categories of information which should be entered. All fixed characters and functional characters are entered automatically for ease of composition and accuracy of format. The completed message is automatically checked for accuracy by the equipment before transmission.

For detection of errors during transmission, an error-check character is automatically inserted at the end of each line of data. Messages which contain errors detected by this means will be directed to the computer supervisor's console printer for manual handling.

The flight-data-entry equipment is being developed for transmission of flight-plan messages over standard teletypewriter code. However, the logical design of its internal circuitry has been planned so that transmission at higher speeds, using six or seven-level code, will be possible with minor modifications.

Ultimately, the quantity of uncoded flight plans received by interphone and teletypewriter will be reduced, reducing the clerical load. Pictorial displays, radar inputs, data links, automatic position reports, and other devices may eventually be worked into the system, and air-traffic control operations, the author concludes, will be equal to the jet-age traffic-control problem.

Heat-Treating 900 Million Parts

PRECISE heat-treating of 900 million parts a year demands the highest standards of operating efficiency. The problem led The National Cash Register Company of Dayton, Ohio, to move all temperature controls off the heat-treat floor into a centralized room overlooking the heat-treat department.

The move involved the addition of new controls and the relocation of older ones. Among the newer instruments were 38 strip-chart, Speedomax H on-off and duration-adjusting-type controllers which supplement the older Leeds and Northrup instruments still in use.

From the centralized room, one man oversees the entire heat-treat operation. He receives records of incoming jobs, schedules the heat-treats, sets the control temperatures, and posts the job number and time in and out of the furnace on the instrument chart itself. This procedure, combined with modern materials-handling techniques and reliable instrumentation, enables NCR to meet high production schedules.

All heat-treating of parts used in their cash registers and accounting machines is done by NCR themselves. Operations include carburizing, hardening, tempering, annealing, and copper brazing. Furnaces are both batch and continuous (electric) and include gas carburizers, cyanide pots, salt pots, lead pots, bell annealers, draw furnaces, induction heaters, and sintering furnaces.

Parts are made of steel—from low-carbon strip to alloys. In order to meet the wear and service standards, each part must meet precise heat-treating specifications. With few exceptions, temperature controls must hold furnace temperatures within ±10 F. This requires high accuracy and reliability in the instruments to provide reproducible results day after day.

Work moves into the heat-treat department on mechanized conveyers accompanied by an iden ifying job sheet. The control-room operator receives a copy of this form which identifies the work by code number.

For each different part an operation card, filed in the control room, gives the heat-treating specifications. With the job identified, the operator pulls the index card on the part to determine his schedule. For example, the index card on part number 123456 might identify the part as a gear which, to meet the hardening specifications, must be quenched at 1700 F after being held at this temperature ±10 F for 3 hr.

Determining the heat-treat required, the operator sets the control-point setter on the Speedomax instrument for the furnace to be used. By Teletalk, he notifies the furnace man on the heat-treat floor that the job is ready to go. He then posts the job number on the instrument chart as well as time in and time due out.

When notified by the control-room operator, the floor man loads the furnace. When the job is finished, the operator again contacts him by Teletalk. He then unloads the furnace and is ready for the next load.

To minimize production delays, NCR has a systematic maintenance schedule. Workers regularly check both the control system and the furnaces.

To locate trouble spots in a minimum time, NCR employs a system to light three signal lights mounted above each Leeds and Northrup recorder controller.

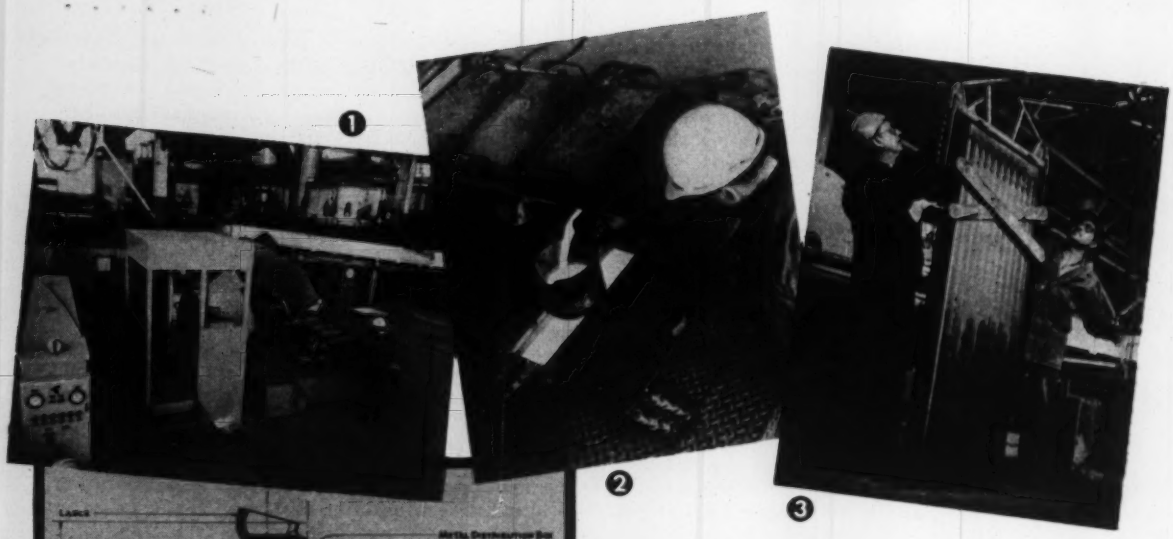
These lights are visible in the panel views, mounted in a horizontal row—colored red, white, and red.

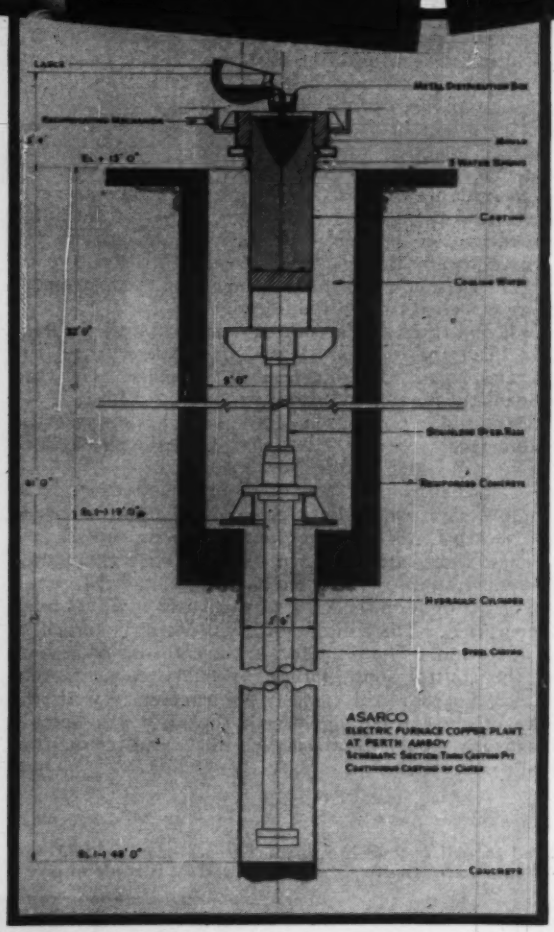
The red light on the left lights when an auxiliary relay is energized. The white light lights when the furnace is in operation. The red light on the right lights as long as the control loop—furnace, primary element, controller, final control element—is complete. With the help of these three signals, the operator can quickly locate any trouble between the furnace and remote-control room.

Operator checks card index for heat-treat specifications

Job number, heat-treat required as well as time in furnace and time due out are posted on instrument chart

Furnace man is told that heat-treat is ready to go





Operator in the booth electronically controls the entire process at the first unit to continuously cast tough-pitch copper cakes: 1 Molten copper at 2100 F flows from the holding furnace, *center,* into the special pouring ladle and through the distributor into the mold. 2 There are two molds, side by side, each of which is cast continuously at 1500 lb per min. 3 Copper slabs 25 in. wide × 5 in. thick and 25 ft long weigh over 5 tons. 4 The new installation can produce more than 160 tons of these huge cakes per 8-hr shift. 5 Finished lengths of continuous cast cake are stacked for shipment.

Continuously Cast Copper Cakes

THE world's first commercial unit to continuously cast tough-pitch copper cakes—the huge slabs from which copper sheet and strip are rolled—has been installed by American Smelting and Refining Company at its Perth Amboy, N. J., refinery. Asarco's new process, regarded as a major breakthrough in nonferrous metallurgy, permits casting of copper cakes up to 25 ft long × 36 in. wide, weighing over 17,000 lb, and production in excess of 160 tons of copper per 8-hr shift.

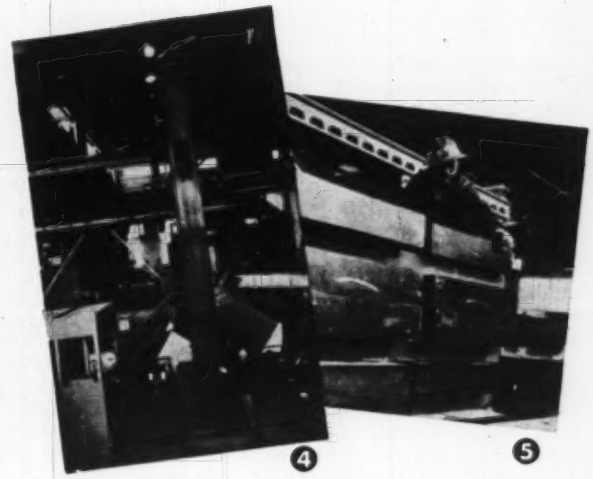
The conventional method of manufacturing tough-pitch copper cakes has been to cast them in individual, water-cooled copper molds. The type of mold customarily used yields a cake 25 to 36 in. wide, $4\frac{1}{2}$ to 7 in. thick, and 36 to 92 in. long. Such cakes weigh between 2000 and 3000 lb.

With the longer lengths now available to them, copper rolling mills will be able to roll more copper per hour, with a consequent gain in plant efficiency and reduction in operating costs. Moreover, the metal cast by the new method is unusually sound and dense and has a surface uniformity which is ideal for rolling. These factors contribute to quality improvement of rolled-copper sheet and strip.

The unique Asarco casting technique eliminates batch casting in costly old-style individual metal molds by use of a small, "bottomless" water-cooled graphite mold. Molten copper is poured continuously into the mold cavity, is cooled so rapidly that it solidifies as it passes through the mold, and emerges from the orifice as a smooth, dense copper cake.

The mold is the key to the Asarco process. It is only 15 in. deep, but has a heat-dissipation rate of about 1500 hp believed to be the highest per square inch of surface of any mold ever built for metal casting. The design enables the mold to solidify molten copper, cast at 2100 F, as it traverses the mold's 15-in. depth at a speed of up to 20 ipm for a 5-in. × 36-in. cake. This is equivalent to 1150 lb of copper per min.

The Asarco mold design eliminates the need for mold-preparation compounds such as are used in conventional water-cooled copper molds. To prevent the cast copper



from sticking to the mold and to insure a smooth cake surface, the entire mold assembly is oscillated by a reciprocating gear. The vertical stroke is only a fraction of an inch and the variable-speed driving motor can operate up to several hundred cpm.

At the present time, the Asarco-developed technique is being used to continuously cast tough-pitch copper, which represents about 90 per cent of U. S. consumption. However, the versatility of the process is such that it can be used with minor modifications to produce cakes of oxygen-free, phosphorized, or other special coppers.

At the Perth Amboy installation the mold is situated at ground level at the mouth of a specially constructed 61-ft-deep water-filled well. As the solid cake emerges from the bottom of the mold it is cooled by a series of high-speed water-spray jets. It then is lowered continuously into the reservoir of cooling water.

The cooling water is circulated by an 1800-gpm pump. As one precautionary measure, a duplicate pump is installed in the system which will cut in automatically if the operating pump should fail. In addition, a 500-gpm emergency pump operating from an independent power source will take over in case of primary power failure. The heat-dissipation capacity of the entire cooling system is rated at 5800 hp—sufficient to cool a building with $1\frac{1}{2}$ times the cubic footage of the Chrysler building.

The cake is lowered into the well by a stainless-steel hydraulic ram which has a 27-ft stroke and lowers at a constant rate regardless of load. The ram and its actuating equipment are completely submerged in water. The withdrawal ram, rate of casting of metal, cooling system, and other vital elements of the casting shop are electronically controlled. One operator can govern the entire casting operation from the electronic control center located in a booth a few yards from the casting pit.

After the cake is cast, the mold is swung to one side and the 25-ft 17,000-lb cake is lifted by a 10-ton crane to a nearby platform. There it is sawed to the precise lengths which are specified by customer rolling mills. The unusual capacity saw cuts at a speed of 4 fpm.

As it is now installed, the casting shop includes two molds side by side. The new unit is capable of casting two cakes simultaneously at a rate up to 20 ipm.

Folding Car

A PROTOTYPE folding automobile which weighs only 700 lb and measures only 20 × 28 × 104 in. when folded has been produced by Hunting Aircraft, Ltd., Luton, Bedfordshire, England.

For use in airborne operations, the four-seater vehicle, called the Harrier, requires less than $1/10$ the air-cargo space of a conventional jeep. Units can be stacked without racks and can be unfolded and ready to drive in one minute.

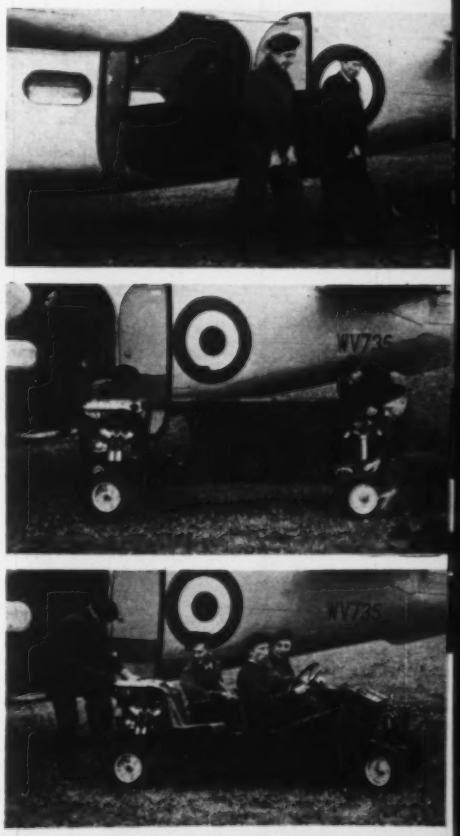
A 650-cc BSAA-10 twin-cylinder engine mounted at the rear end of the central tubular-chassis member drives the rear wheels. It is a removable unit which includes a motorcycle-type gearbox that provides four forward ratios.

The drive is taken by a vertical chain from the gearbox to a layshaft mounted across the chassis and then to the center portion of the rear cycle by a horizontal chain running in an oil bath in the chassis member. The drive then passes to the rear wheels through pairs of universal joints which allow for vertical wheel movement, splined joints being incorporated to allow for corresponding variations in the length of the final drive. To obviate wheel spin on rough ground, no differential has been fitted, although this can be added if required.

Steering is by a simple rack and pinion system, the rack being housed in a transverse tube across the front of the chassis member and connected to the front hubs by ball-jointed links which are so designed that the front wheels fold without disconnecting the steering.

Braking is mechanical, the front and rear pairs of brakes being self-balancing and designed so that failure at any point leaves at least one pair of brakes effective.

The clutch control is incorporated with the gear lever which is mounted on top of the chassis member, gear-changing being effected by a single movement of the driver's left hand.



Four-man crew of the Harrier lifts it out of the aircraft. Front wheels are swung down and connected, and the rear wheels swung out and down. After the sides of the case have been dropped to form the floor, folding seats erected, front and rear stands raised, the car is ready to be driven away.

Screw-Thread Metrology

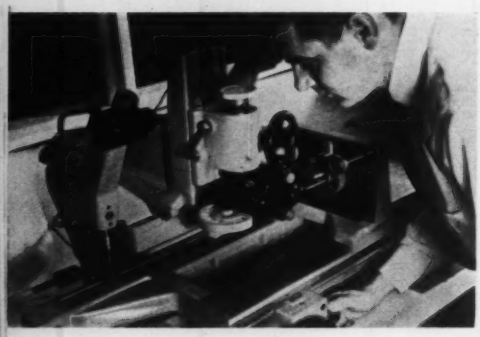
STANDARD PRESSED STEEL COMPANY has opened the first two of three screw-thread-metrology laboratories at its headquarters plant in Jenkintown, Pa., and at the Cleveland, Ohio, plant of a subsidiary, The Cleveland Cap Screw Company.

The third laboratory will open in March at SPS Western—new West Coast division of the company nearing completion in Santa Ana, Calif.

The three nearly identical units will make available to precision-industrial-fastener users seeking its service more than $300,000 worth of the most advanced screw-thread measuring equipment.

Equipment and techniques available at the SPS Screw Thread Metrology Labs for untangling thread problems will be similar to those developed and used successfully by SPS for control of its own precision fasteners.

One of three new threaded-fastener size-control laboratories opened by Standard Pressed Steel Company



Universal-measuring machine checks pitch diameter of internal screw threads to within 0.000010 in.

Some of the precision-measuring machines will check critical thread dimensions to the nearest millionth.

The screw-thread laboratories will be completely equipped for threadsize control of Classes 3A, 3B, 2A, and 2B unified screw threads and of ANPT and NPTF types of tapered threads. These external and internal screw-thread classifications include most of the precision fasteners used by industry. The tapered threads are those used on pressure plugs and other precision fittings for hydraulic systems, pressure vessels, and tanks.

For its study of fit problems, each lab is equipped to measure all screw-thread elements—diameters, angles, lead, radii, and others; to check and, if needed, set related thread gages and set masters; and even to run close dimensional checks of the possibly faulty threading tools themselves.

The labs will advise and aid fastener users in setting up reliable inspection-gaging systems in their own plants, and in general serve as a clearinghouse of information on thread-fit and gaging matters.

Pelletized Lignite

A SATISFACTORY pelletized fuel can be developed from fine sizes of lignite now being stockpiled in the Midwest for lack of market, according to Bureau of Mines tests conducted at the lignite Experiment Station, Grand Forks, N. Dak.

These small pieces of lignite were properly dried and mixed with a binder to form pellets which not only burn well but can be stored and handled without disintegrating. The best drying temperature proved to be about 600 F and the most satisfactory binder was briquetting asphalt applied in a rotating-drum pelletizer.

The lignite pellets appeared to burn best in thin firebeds such as those on traveling grate stokers.

A copy of the report, which should be identified by number and title—R. I. 5382, "Thermal Pretreatment and Pelletizing of North Dakota Lignite," by W. H. Oppelt, W. R. Kube, J. P. Gooney, and E. F. Golob—can be obtained by writing the Publications-Distribution Section, Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

Flue-Design Models

SCALED transparent-plastic working models are being used by Research-Cottrell to study gas-flow patterns for improvements in the flue design of electrostatic precipitators. Ten models built in two years of study at the company's Bound Brook, N. J., laboratories have indicated several areas in which dollar savings to industry can be achieved.

Model studies have been proved in practice to such an extent that Research-Cottrell now offers three types of contracts involving model studies. The first requires the building of a model, study of flue design, and recommendations without a performance guarantee. The second is the same as the first except that performance is guaranteed. Under the third type of contract, Research-Cottrell undertakes responsibility for design, fabrication, and erection of the flues and guarantees performance.

Studies of costs of the models built to date indicate that a model varies from 1 to 2 per cent of the cost of the precipitator.

A model can be built in 6 to 8 weeks after preliminary drawings have been prepared. An engineer in the model shop scales the drawings down to $^1/_{16}$ of the commercial size, or $^3/_4$ in. to 12 in. Four technicians cut the parts from $^3/_{16}$-in. Plexiglass sheets using wood-working power tools such as a saw, sander, joiner, and drill press. In a few models $^1/_8$-in. and $^1/_{16}$-in. sheets are used.

Two test engineers study flow patterns by means of threads, ribbons, ground cork, or dust. Most flow-pattern studies are made with smoke. Anemometers and pitot tubes are used to take velocity and pressure measurements.

Room air is induced into the models by a fan having a capacity of 5000 cfm at 21 in. w.g. (water gage) driven by a 25-hp motor. Two smaller blowers are also used.

The rate of circulation and pressure drop are important considerations in precipitator design, the greater the pressure drop through the flues the larger the fan and motor must be to force or induce gas through the system. Industry estimates that a pressure drop has a direct dollar equivalent. Measured in terms of inches of water, each in. w.g. can be capitalized at from $40,000 to $80,000. Research-Cottrell has shown by models that it is possible to design flues to reduce pressure loss from $^1/_4$ in. to over 1 in. w.g.

By bringing the gas to be cleaned to the precipitator in a more uniform manner, without turbulence and evenly distributed over all the plates, two approaches to precipitator design are possible: (a) Smaller precipitators can be used to attain a given efficiency; (b) a larger volume of gas can be treated in a precipitator of given size. In addition, the extra plate capacity, designed into precipitators in the past as a safety factor because gas flow was erratic, is no longer required.

Model studies have shown that certain components can often be eliminated or their function replaced by less costly devices. Model studies showed that drop-out hoppers increased turbulence and pressure drop. Gas currents entered the hopper and stirred up as much dust as it trapped. Dust build-up could be prevented by soot blowers. The material previously needed for hoppers and the labor of construction were eliminated.

As in all research, many findings are basic and negative results are as useful as positive. For example, baffles, flow splitters, or vanes have little or no effect on guiding gas flow in three dimensions. Further research with baffles has been stopped.

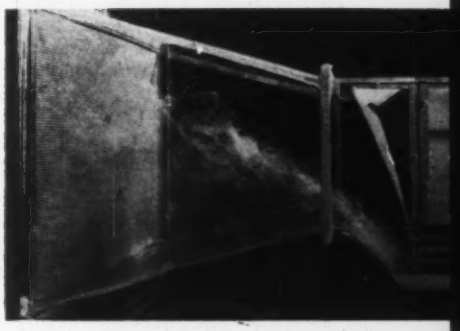
Most of the problems of gas flow in flues were found to involve shock patterns caused by sharp changes in flow direction, sharp changes in flue cross section, and sharp changes in flue shape—from round to rectangular. The importance of maintaining the correct Reynolds number in shock-pattern analysis has been found to be of little importance as long as it is above a critical value.

The proper utilization of perforated plates is of the utmost importance. Model study showed, for example, that a perforated plate should not be placed in a vertical position over the opening in a hopper, since gas flowed under the plate sweeping dust out of the hopper. The open area of the plate is important. The distance from one plate to another is critical, as well as the distance of a plate from the precipitator. The effect of multiple plates was found to warrant further study.

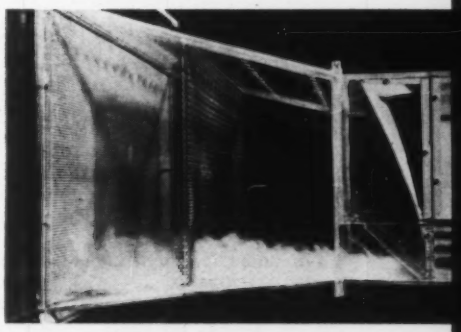
An open space or slot is commonly designed between the perforated plate and the floor of the flue to allow the moving gas to sweep away the dust that might build up at the plate. Studies are now being made of the jet effect of the slot.

A number of specific improvements have been made with the model method. A 15 per cent decrease in pressure drop resulted from hopper and flue changes in the design for Potomac Electric Power Company's Montgomery County, Md., plant which operates at 984,000 cfm at 245 F with $97^1/_2$ per cent efficiency. In a 1,400,000 cfm installation on Staten Island for Consolidated Edison changes were made in flue configuration. Round posts were used to equalize pressure drop through the vanes and to provide uniform flow and a reduction in turbulence.

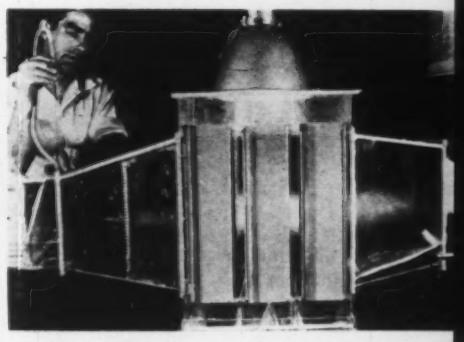
Model built to determine the best flue design for a precipitator to be installed in limited space



Original design of flue section created turbulent flow because of drastic change in cross section



After eliminating the sharp angle between the air heater and the floor of the flue, flow is more uniform



Complete model includes air heater, inlet flue, precipitator, and the outlet flues to stack

Atomic Energy in India

"The Indian atomic energy program is of a very modest size, compared with the programs in the United States, the Soviet Union, and the United Kingdom," and "it has no military component" according to an article by Homi J. Bhabha in the British journal *Nature*. Dr. Bhabha, widely known for his work in the nuclear field, served as president of the 1955 Geneva Conference on the Peaceful Uses of Atomic Energy.

Although the Atomic Energy Commission was established as an advisory body in 1948 in the Ministry of Natural Resources and Scientific Research, no important effort to develop this work was made until a separate department of the Government of India, with the full powers of a ministry, was established in August, 1954.

With per capita coal reserves of only $^1/_{150}$ that of the United States, which would last only ten years at the U. S. rate of consumption, and one of the largest deposits of monazite in the world, the advent of atomic energy radically changes the long-range power picture.

The known Indian reserves of uranium and thorium become equivalent in energy value to more than thirty times its reserves of coal. Also, transportation costs for coal would make nuclear power already competitive in some areas.

APSARA, India's first atomic reactor of the swimming-pool type, became critical for the first time on August 4, 1956. It is the first reactor to go into operation in Asia, outside the USSR. It was designed, engineered, and built entirely by Indians and by Indian industry, except for the fuel elements. These, which contain enriched uranium, have been provided by the United Kingdom Atomic Energy Authority.

The next step considered was the building of a powerful high-flux reactor for engineering research. Several types were being considered when the Canadian Government generously offered to set up a reactor of the NRX type in India. This reactor should be completed by the end of 1958. It requires 20 tons of heavy water sold to India by the U. S. Atomic Energy Commission.

A third, zero-energy, reactor for the study of the effect of different lattices, shapes, and sizes of fuel elements, mixed lattices containing uranium or plutonium and thorium, and so forth, is under construction and should be completed in 1958.

The immediate need in many parts of India is for small power stations of 20 to 50 megawatts, and reactors moderated with beryllium oxide, gas-cooled, and working on natural or slightly enriched uranium, will be studied for this purpose. The critical size of beryllium-moderated reactors is smaller than for graphite-moderated reactors, and preliminary calculations show that they may well be more economical in the power range below about 20 megawatts.

For this purpose India has had for some years a joint project with the Commissariat à l'Énergie Atomique for studying the properties of beryllium oxide as a moderator. A small group at the Trombay Establishment—the center of Indian nuclear-energy research and development—is now actively engaged in feasibility studies on reactors moderated with beryllium oxide of a power output of less than 30 megawatts.

Dr. Bhabha concludes that: "Only a modest beginning has been made, but one that holds out promise of important developments, which may well help to accelerate the industrialization of India."

Nuclear Briefs

▶ Merchant Ship Reactor Experiment

Criticality has been achieved with the experimental reactor which Babcock & Wilcox have built near Lynchburg, Va., in developing the nuclear-propulsion system for the first nuclear-powered merchant ship, the NS *Savannah*.

Scheduled for completion in 1960, the *Savannah* will be powered by an advanced type of pressurized-water reactor. The reactor plant will deliver a maximum of 22,000 shaft-hp. Estimates of the power plant's capability run as high as 350,000 miles on a single core loading of nuclear fuel.

▶ Advanced Epithermal Thorium Reactor

An advanced nuclear-reactor concept to produce economic electric power from atomic energy will be studied in a $5,354,000, four-year research and development program by Atomics International, a division of North American Aviation, Inc., for the Southwest Atomic Energy Associates, investor-owned electric companies in Arkansas, Kansas, Louisiana, Mississippi, Missouri, Oklahoma, and Texas. The Advanced Epithermal Thorium Reactor concept, AETR, will be studied with a view to the construction of one or more full-scale atomic-power plants. The associated companies are the utilities which formed the Southwest Power Pool during World War II and the principal suppliers of power in the states they serve, representing a total installed capacity of 6,250,000 kw.

In the AETR concept, thorium is converted to U-233 in the breeding process and added to uranium originally placed in the reactor for fuel. Sodium would be the coolant to transfer heat from the reactor core, and, if moderated, beryllium or graphite would be used. The nuclear power plant would be rated at approximately 200,000 electrical kw.

The Atomic Energy Commission has indicated that the program appears to be a logical extension of work now in the AEC's program for the development of sodium-cooled, graphite-moderated civilian power reactors.

▶ $4-Billion Nuclear Equipment Sales

U. S. manufacturers can look forward to an estimated $4-billion sales of equipment and components for U. S. and foreign nuclear reactors over the next ten years, according to a recent survey by the Atomic Industrial Forum, Inc.

The survey has been in preparation for a year by the Washington consulting firm, Pickard-Warren-Lowe Associates, and updates and re-evaluates the forecasts in an earlier Forum report published in May, 1955.

Expenditures for support of civilian-power-reactor development, on the basis of present commitments, are expected to total $150 to $180 million annually until 1960 or 1961. Of this annual total, $90–100 million are expected to be contributed by the U. S. government, $50–60 million by private utility firms, and $10–20 million by manufacturers of reactors and reactor components.

The complete report is available for $25 to nonmembers of the Atomic Industrial Forum, Inc., 3 East 54th Street, New York, N. Y.

Missile Miscellany

▶ Liquid-Propellant Rocket Engine

A ROCKETDYNE liquid-propellant rocket engine burning Hydyne, a new high-energy fuel compound, and liquid oxygen provided the critical first-stage power to lift the Army's Jupiter-C satellite missile into outer space in the January 31 launching.

Hydyne's properties nearly duplicate those of alcohol, the conventional Redstone-engine fuel. By designing the new compound to achieve that duplication, Rocketdyne engineers substantially increased specific impulse, thrust, and missile range without the costly modification of engine components.

The Redstone engine series, rated in the 75,000-lb thrust class, has been in production by Rocketdyne since 1952. The first U. S. high-thrust rocket to reach that state of development, the engine series has achieved reliability of 99 per cent in flight and static tests.

Smaller than a sports car, the Redstone engine—from which the Jupiter C booster was adapted—produces high-energy gases reaching temperatures in excess of 5000 deg inside its thrust chamber. It is cooled by fuel circulating through the double walls of the chamber.

Propellants are pumped into the combustion area of the engine by a compact turbopump. Its turbine is driven by high-velocity steam developed through the decomposition of hydrogen peroxidei n a midget generator.

Redstone engines are produced by Rocketdyne, a Division of North American Aviation, Inc., at Canoga Park, Calif.

▶ Missile Needs Boost Accumulators

The need for compactness and cleanliness in raising pressures of gases used for testing and operating missiles and rockets has resulted in the development of compressors using accumulators instead of pistons, according to Greer Hydraulics, Inc., Jamaica, N. Y.

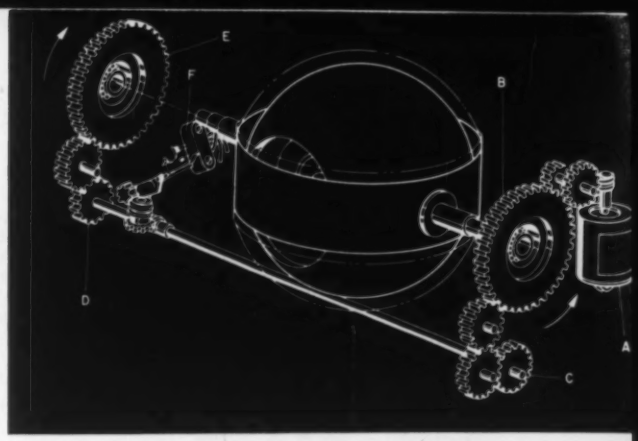
By pumping oil against one side of an expandable sealed bladder in each of a series of 10 accumulators, the pressure of gas is raised from the 2200 psi at which it is commercially available to as high as 10,000 psi. The expansion of the bladder serves the same function as a mechanical piston.

The basic difference in the accumulator booster system is that the gas leaves the system with the same cleanliness with which it entered. There is no possible source of contamination since the bladder completely seals the gas from the oil.

The need to keep the required gases chemically pure is further assured by the incorporation into the system of a photoelectric device which immediately detects oil contamination from a possible bladder rupture to 100 ppm.

The gases are used at high pressures for charging missile systems prior to flight, charging large, high-pressure gas receivers at rocket test facilities and in small airborne gas supplies.

A single pump serves all 10 accumulators. The gas content of each accumulator becomes available automatically when the desired preset pressure has been reached. Thus where demand is intermittent, the accumulator system can provide compression with units that are as little as $^1/_{10}$th the size of comparative conventional-compressor systems, and require as little as $^1/_2$ the horsepower.



How the Sperry Rotorace works: Motor *A* drives gear *B* to rotate race of bearing in direction of arrow. Motion is transmitted from gear cluster *C* through shaft to *D* which turns bearing *E*. Races of bearings at *B* and *E* turn at the same speed in opposite directions, effectively averaging "out" errors. Mechanism *F* periodically reverses rotation.

▶ Gyro Improvement

Low-cost, early achievement of extremely accurate gyro systems for stabilizing and guiding missiles, aircraft, and even sea vessels has been made possible by development of "frictionless" gyros by the Sperry Gyroscope Company, Great Neck, N. Y.

A closely held company secret for more than a year, the development hinges on a unique method for controlling ball bearings within "simple" gyroscopes.

The Rotorace principle eliminates error-producing torques in gyro gimbals, the major cause of random-drift error in the critically important direction-sensing devices, without significant increase in weight, cost, complexity, manufacturing, or maintenance problems.

The high accuracies afforded by Rotorace gyros have been made possible through constant rotation of the ball bearing in each of the gyro's two gimbals—first in one direction, then in the other—in a controlled manner, which (*a*) averages and minimizes bearing friction; (*b*) averages "out" the errors caused by minute irregularities found in even the finest ball bearings; (*c*) prevents pitting and wearing of certain balls in each bearing because of the latter's tendency to remain static during operation.

Rotorace in extensive laboratory tests regularly shaves random-drift rates of nonfloated gyros to 0.1 deg per hr, and even halves that to 0.05 deg per hr and better under controlled conditions.

A compressor used as a gas booster in testing missiles and rockets is equipped with ten hydropneumatic accumulators of 20-gal capacity each

1 **Aluminum Geodesic Dome.** The new headquarters building designed for the American Society for Metals features an aluminum geodesic dome, or "space lattice," (250 ft x 103 ft) a semicircular concrete and steel building in three levels, and a 400-ft diam garden piazza. The $2,000,000 project will be located east of Cleveland.

2 **Liquid-Cooled Brake.** A new liquid-cooled brake system for aircraft that prevents temperature build-up on braking surfaces by as much as 1500 deg has been announced by B. F. Goodrich Aviation Products. It was developed for the Air Force under sponsorship of the Air Research and Development Command. Heat is taken from the critical wheel and brake area and carried to a point where it can be dissipated at low temperatures. Tests at ARDC's Wright Air Development Center showed that it performed consistently without fade in consecutive stops, at maximum temperatures below 500F.

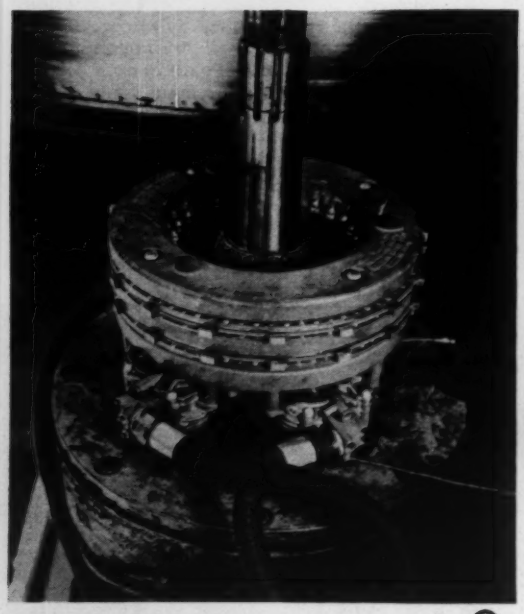
3 **Bomarc Missile Engine Tests.** Test stand made by Greer Hydraulics Inc., in Jamaica, Long Island, N. Y., to test ramjet engines checks out components of fuel, hydraulic, electric, and other operational systems. Technicians make final checks before the stand is shipped to Patrick Air Force Base in Florida.

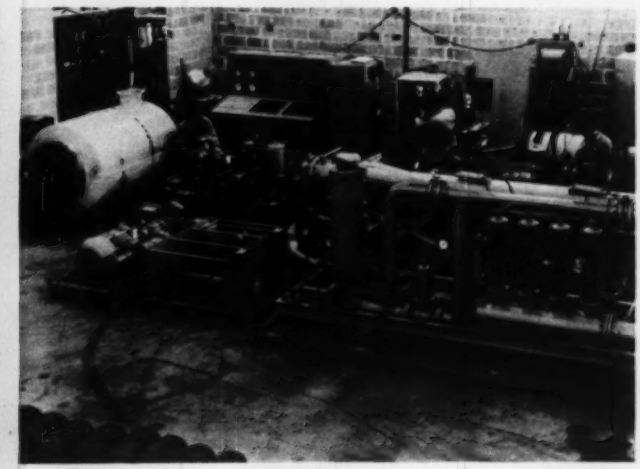
4 **German Reactor.** This 50-kw nuclear reactor built by Atomic International a division of North American Aviation, Inc., for the Max Planck Institute for Nuclear Physics of the University of Frankfurt in West Germany is now in operation there. German scientists are shown conducting radiation measurements at an exposure port of the "solution type" reactor which uses enriched uranium 235 in a water solution as fuel.

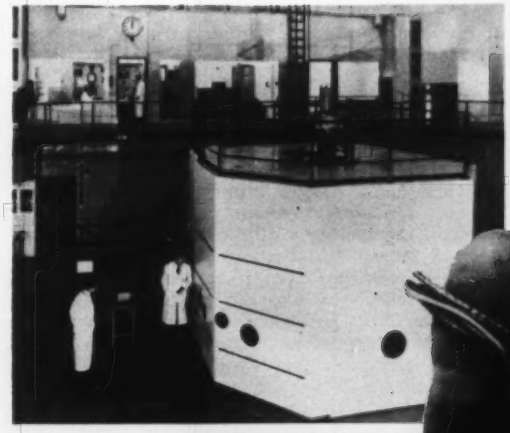
5 **TALLescope.** This telescoping aluminum work platform for overhead spot maintenance at heights up to 30 ft is being manufactured by Up-Right Scaffolds, Berkeley, Calif. Called TALLescope, it is lightweight and rapidly assembled by one man. Legs are adjustable for uneven floors or stairways. Structure is only 29 in wide.

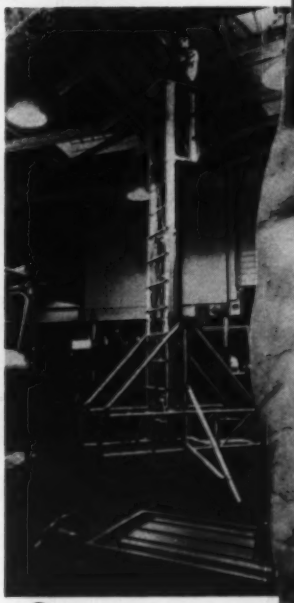
6 **Heat Seared X-7.** Burned to a black waffle pattern by searing air friction heat, the Lockheed X-7 ramjet missile has set a new speed mark for air-breathing vehicles. The Air Force also said the "bird" set a new altitude record for ramjet missiles, bordering on the fringes of the earth's atmosphere. The X-7 is used to prove powerful ramjet engines. It is recoverable by parachute and nose spike to be flown time and again.

7 **Plywood-Molded Pipe.** A plywood-molded pipe that can be produced economically in any diameter, and lined with any type of material, has been announced by Plycraft, Inc., of Lawrence, Mass. This new plywood pipe is noncorrosive, low in price, light, and easy to ship, handle, and install.









Missile Gyro

New subminiature rate integrating gyro for missile guidance and airborne armament control systems, developed by the Westinghouse Electric Corporation's air arm division in Baltimore, Md., has achieved manufacturing economies by redesigning and simplifying. A cost reduction of as much as 50 per cent over comparable gyros is possible.

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

Diesel-Hydraulic Locomotives

THE $3500-million plan for the modernization of the British Railways system envisages electrification for all the mainline routes, but meanwhile, as the building of steam locomotives will cease long before the electrification can be completed, diesel engines will be used increasingly to replace steam on both main and branch lines. The first diesel mainline locomotive with hydraulic drive for the Western Region of British Railways—for hauling express trains from London to Bristol and the West of England—made its appearance in mid-February. It is a 2000-hp unit and will soon be followed by 71 more of the same size and 58 of 1000 hp; together, these 130 will replace about 200 steam locomotives.

The D.600 class, to which this prototype belongs, has the following dimensions: length over buffers 65 ft, wheelbase of each six-wheeled bogie 15 ft, driving wheel diam 3 ft 7 in., and carrying wheel diam 3 ft $3^1/_2$ in. The wheel arrangement is A-1-A, A-1-A. The weight in working order is 117 tons 8 cwt, the fuel capacity 800 gallons, the water capacity 1000 gallons, and the maximum speed 90 mph; the maximum tractive effort (30 per cent adhesion, at continuous rating) is 50,000 lb.

The power units are two 12-cyl V-type engines of M.A.N. design, constructed under license by the North British Locomotive Company, who are the builders of this locomotive and a number of others of the batch, as well as the 58 of 1000 hp. The cylinders are 180-mm bore and 210-mm stroke, and have wet-type cast-iron liners. There are two inlet and two exhaust valves to each cylinder. The pistons have four pressure rings (the top one being chromium-plated) and two scraper rings. The bearing shells are steel, copper/lead-lined, for both main and big-end bearings. The engines are pressure-charged by means of Napier exhaust turbochargers, and the rated output for each unit is 1000 bhp at 1445 rpm or 1100 bhp at 1500 rpm.

The transmission consists of hydraulic torque converters of the Voith type, developed by the J. M. Voith Maschinenfabrik, of Heidenheim, Germany; like the engines, these are constructed under license by the North British Locomotive Company. There are two separate transmissions, each connected to one of the 1000-hp engines through a Hardy-Spicer cardan shaft. The transmission contains three torque converters. Each will give an infinitely variable torque, but one is designed to be most efficient at starting and low speeds, another at intermediate speeds, and the third at high speeds. One is filled as another is emptied, the transmission of torque to the wheels being unaffected. Reverse gears are incorporated in the transmissions and are controlled by electropneumatic valves.

The main frame of the locomotive is built of mild steel plates and sections, the main longitudinals being of I-section. The six-wheeled bogies are of double-plate design, constructed of welded and stress-relieved subassemblies. The axles run in grease-lubricated Timken roller bearings. The Westinghouse vacuum-controlled straight air brake is fitted, the driver's vacuum-brake valve applying the train brakes and making a proportional application of the locomotive's air brakes. For train heating there is an automatically regulated Spanner boiler, working at 80 psi.

Diesel-hydraulic locomotive built by North British Locomotive Company for the Western Region of British Railways. The weight in working order is 117 tons 8 cwt, the fuel capacity 800 gallons, the water capacity 1000 gallons, and the maximum speed 90 mph. 2000-hp diesel engines of this type are being used to replace steam on both main and branch railway lines in Britain. Interior view of engine compartment, *right*, looking toward boiler compartment.

Grating Polychromator Analyzes Steel

THE Duisburg steelworks of the Phoenix-Rheinrohr Aktiengesellschaft, Germany, has recently installed a 3-meter-grating polychromator for the rapid automatic analysis and recording of the composition of alloy steels and slags containing phosphorus, manganese, and chromium. The apparatus, the first large automatic spectrograph of British design and manufacture to be sold abroad, was designed and constructed by the instrument-making firm of Hilger & Watts, Ltd., 98 St. Pancras Way, London, N.W.1, England, and was taken all the way to Duisburg by water so that it might be landed on the purchaser's own quay with the minimum of intermediate handling.

It is capable of analyzing an alloy for any number up to 29 constituent elements and printing the result on a paper strip within four minutes of pressing the starting button. The equipment consists of four parts: the source unit, the spark discharge stand, the grating polychromator, which is fitted with photomultipliers for receiving the light of selected spectral lines, and the electronic console which controls the operation of the instrument and interprets and records the results.

The discharge stand is so designed that the electrode gap is always precisely reproducible, being mechanically set by means of a metal gage. The light from the discharge is admitted to the polychromator through a horizontal slit of fixed width and falls on a plane mirror, adjustable for tilt by a micrometer screw, and is reflected to the grating, which is concave, with a radius of curvature of 3 meters, and is ruled usually with 14,400 lines to the inch (though it is available also with 28,800 lines) over a ruled area of 8 cm × 4 cm. This disperses the light into a spectrum formed at the Rowland circle, along which exit slits, with the regions between them masked, are disposed to isolate the lines required for the analysis. Behind each exit slit is a small concave mirror which reflects the light onto the cathode of a photomultiplier, forming on the cathode an image of the grating.

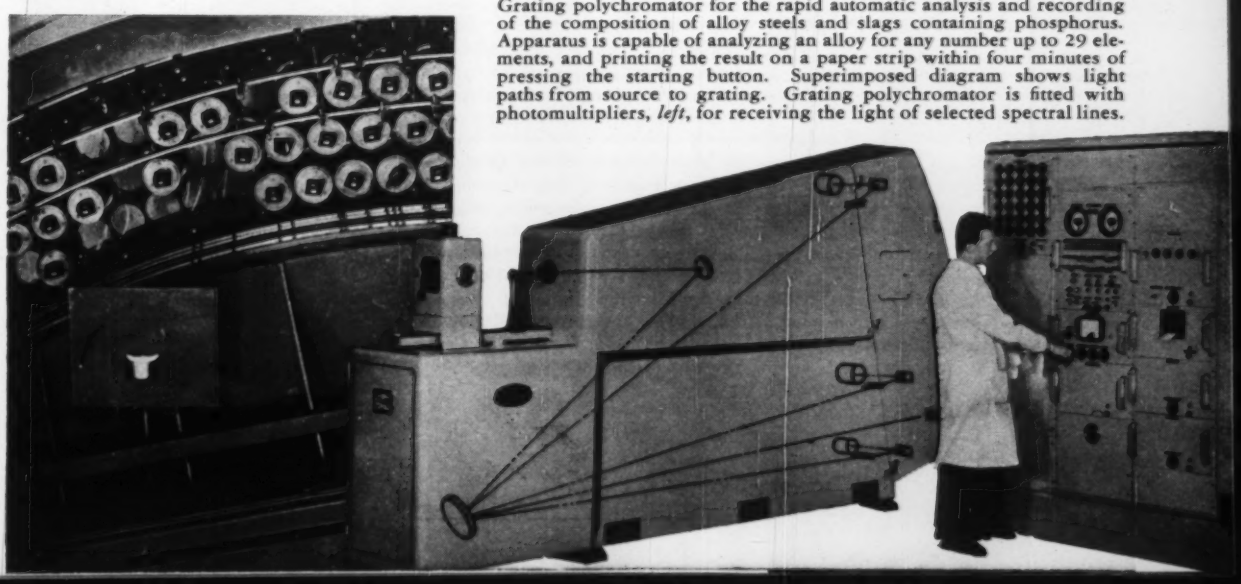
The maximum number of photomultipliers is 30, but they may be placed in any of 50 possible positions. The output of each photomultiplier is stored by one of 30 capacitors in an integrator unit which also contains relays for performing the various switching operations needed in the measuring cycle. At the end of an exposure the potential of each capacitor is proportional to the intensity of the spectral line received by the corresponding photomultiplier. The reading is displayed by four dekatron tubes and automatically printed on a paper strip, together with the number of the photomultiplier concerned.

New Periodical—"Wear"

AS AN indirect result of personal contacts made some years ago at a conference in Delft, Holland, a new venture in international collaboration for the publication of scientific studies has recently taken shape with the appearance of a periodical entitled *Wear*, described as "an international journal on fundamentals of friction, lubrication, wear, and their control in industry." That describes it, but not completely, for it combines at once the functions of an abstracting medium, covering the subjects indicated, and a vehicle for the printing of original researches for which it might be difficult otherwise to find a publisher, by reason of their advanced character and consequently limited appeal. The editor is Dr. Ir. G. Salomon of Delft (his address is P. O. Box 71, Delft, The Netherlands) and the Elsevier Publishing Company, of Amsterdam, New York, N. Y., Princeton, N. J., and London, England, are the publishers; but it is in the composition of the honorary editorial and advisory boards that the international character of the undertaking is really brought out. Of the nine members of the editorial board, two are from the United States, two from Great Britain, two from Germany, and one apiece from Australia, Russia, and India.

The advisory board numbers ten, of whom three hail from the United States and one each from Holland, Switzerland, Italy, Russia, Denmark, France, and Japan. All are men who have done original work in the study of friction, lubrication, or wear, and though a majority are connected with university or government-sponsored research, the great industrial laboratories are represented also. The basis of the venture is unusual, and it will be interesting to see whether it spreads into other departments of physics and applied science generally.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.



Grating polychromator for the rapid automatic analysis and recording of the composition of alloy steels and slags containing phosphorus. Apparatus is capable of analyzing an alloy for any number up to 29 elements, and printing the result on a paper strip within four minutes of pressing the starting button. Superimposed diagram shows light paths from source to grating. Grating polychromator is fitted with photomultipliers, *left*, for receiving the light of selected spectral lines.

Substance in Brief of Papers Presented at ASME Meetings

M. ZANFARDINO
Staff Editor

ASME TECHNICAL DIGEST

Machine Design

Measuring the Preload of Ball or Roller Bearings.....57—A-43

By C. L. Emmerich, Norden-Ketay Corp., White Plains, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The basic function of a bearing is to maintain radial and axial alignment between machine elements without interfering with their rotary motion.

In certain instrument applications bearings must perform this function with a high degree of perfection. Large radial or axial stiffness is required while the friction torque about the bearing axis is to be exceedingly small. These specifications are approximated in practice by the use of preloaded ball or roller bearing pairs, known as "duplex bearings."

Since the stiffness of a duplex-bearing assembly increases with preload, but the friction also increases with preload, the design of a duplex-bearing application represents a compromise between conflicting demands. Heavy preloads result in great stiffness at the expense of severe friction losses or even damage to the bearing surfaces whereas a light preload may not produce the required stiffness of the bearing assembly.

It is therefore important to decide on the correct value of the preload and then to make certain that the actual preload achieved is reasonably close to the design value.

In most cases the preload varies drastically as a function of temperature, clearances, bearing dimensions, and alignment, so that the actual preload in a particular assembly may differ considerably from the design value. A direct measure of the operating preload of an assembled bearing pair is therefore an indispensable process in the manufacture of high-quality instruments using preloaded bearings.

This paper outlines two practical methods for obtaining this measurement; namely, by a friction determination or by a displacement measurement.

A Versatile New Engineering Tool —The Precision Clutch.....57—A-244

By W. P. Gregory, Assoc. Mem. ASME, and P. C. Hungerford, Assoc. Mem. ASME, Curtiss-Wright Corporation, Cleveland, Ohio. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Although the mathematical development of spring-clutch theory has appeared in various publications over a period of years, it is felt that a discussion of the previously developed mathematical concepts in the light of recent developments can add considerably to the engineering application and design knowledge of this unique device.

Quite old, in principle, with patents dating back to 1865, recent developments revealing the versatility and minimizing the inherent limitations of the clutch have made it suitable for a wide variety of applications from the delicate requirements of fragile instruments to rugged duty in machine tool drives and feeds.

Basically simple in construction, its attendant economy makes it a component worthy of consideration in the cost conscious consumer products field. On the other hand, its reliability has caused it to find favor in the eyes of precision-minded aircraft designers who list safety as a prime requisite for any component. Any principle having such a broad range of applicability to mechanical design problems merits the close scrutiny of engineers responsible for the design of machines and component mechanisms.

Since the spring clutch was primarily conceived as an overrunning or freewheeling device, most of the application of basic design formulas in this paper are concerned with that type of clutch. Departures are made where other clutch mechanisms present mathematical considerations unique to their own particular functions. Characteristics are considered in the light of present-day knowledge, and recommendations as to the suitability for use in various applications are discussed

The Effect of Fretting on Fatigue Characteristics of Titanium-Steel and Steel-Steel Joints...57—A-113

By W. L. Starkey, Mem. ASME, S. M. Marco, Mem. ASME, and J. A. Collins, Ohio State University, Columbus, Ohio. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Fretting may be defined as that mechanical action whereby the originally contacting surfaces of two solid bodies are pressed together by a normal force and are caused to undergo cyclic relative sliding motion, but where the magnitude of the normal force is great enough and the amplitude of the cyclic motion is small enough to effect a significant restriction to the flow of any fretting debris away from its point of origin. Fretting occurs in machines at interference fits; bolted keyed, or riveted joints; between wires in wire ropes and flexible shafts; in small-amplitude oscillating bearings; between leaves of springs; and any other place where the conditions of fretting persist.

Fretting often gives rise to additional phenomena such as fretting corrosion, fretting wear, or fretting fatigue. Fretting corrosion may be defined as any corrosive action which results from fretting. Fretting wear may be defined as any wear damage which results from fretting. Fretting fatigue may be defined as any fatigue damage which results from fretting. The primary detrimental effects of fretting on machine parts are: (*a*) Corrosive surface damage due to fretting corrosion; (*b*) loss of fit due to fretting wear; and (*c*) fatigue failure due to fretting fatigue. This paper is primarily concerned with fretting fatigue.

The specific objectives of the investigation are as follows:

1 To evaluate the fatigue damage caused by fretting steel against titanium.

2 To evaluate the effectiveness of shot-peening as an inhibitor of fatigue damage caused by fretting steel against titanium.

3 To evaluate the effectiveness of

cold-rolling as an inhibitor of fatigue damage caused by fretting steel against titanium.

4 To evaluate, for purposes of comparison, the fatigue damage caused by fretting steel against steel.

5 To evaluate, for purposes of comparison, the nonfretted fatigue properties of both titanium and steel.

6 To perform other supplementary or control tests.

The results of the investigation indicate that systems of stress concentration and other effects due to pit digging, asperity contacts, and cyclic nominal stress field in the part all combine their influence to initiate and propagate fatigue cracks. Many such cracks have been observed in microscopic examinations of fretted specimens.

Cold-rolling and shot-peening, both of which are forms of cold-working, each provide a skin layer of residual compressive stresses which are unfavorable to crack propagation. By providing an optimum residual-stress field, it therefore appears that the damaging effects of fretting fatigue can be greatly reduced. Other methods of producing residual surface compressive stresses such as nitriding or flame plating also should be beneficial in certain applications.

The trapping of fretting debris is an important factor in the later stages of fretting. Since most oxides reflect a substantial increase in volume compared to the parent metal (1.73 for TiO_2 and 2.14 for Fe_2O_3), the oxide debris may result in high local pressures if trapped in the valleys below the asperities. These high pressures tend to accelerate the formation and propagation of fatigue cracks leading to fretting-fatigue failure. Any means of preventing the formation of debris or removing debris as it is formed also should aid in the mitigation of fretting fatigue. However, the formation of highly local microscopic pockets of debris are extremely difficult, if not impossible, to prevent.

Additional research on the basic mechanism of fretting fatigue is essential. Only with an understanding of the fundamental actions involved in fretting can a completely satisfactory solution to the problem be attained.

Analysis of Hindley-Worm Drive.. .....57—A-159

By I. Yoshimoto, Tokyo, Japan. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Hindley-worm drive or cone-worm drive is a form of hourglass worm drive. The worm is formed by a straight-sided tool; and the worm gear is produced by a hob which is of the form of the worm.

The contact condition of this worm drive has been analyzed by two investigators, Yamamoto and Buckingham. The numerical calculations in their analyses are complicated, and their results seem to differ.

This paper presents the simplification of the numerical calculations in this analysis and the comparison between these two investigations.

The contact conditions are analyzed by the simplified method in three cases where the number of threads on the worm is one, three, and nine.

Spiroid Gearing.....57—A-162

By W. D. Nelson, Illinois Tool Works, Chicago, Ill. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Spiroid gearing is a recently patented development in the field of skew-axis gearing and offers another solution to the gear problem. The question, "What should spiroid gearing mean to the designer, the manufacturer, and the consumer?" is considered.

The spiroid system offers the designer an opportunity to approach new developments and to re-evaluate old designs in terms of a new concept in gearing. Application of the spiroid system usually results in a smaller package since, for a given gear OD, the spiroid pinion is placed on the side of the gear instead of the periphery as in conventional worm designs. Both weight and cost savings are often realized when a single reduction of spiroid gears eliminates multiple spur reductions, worm-helical, or double worm reductions.

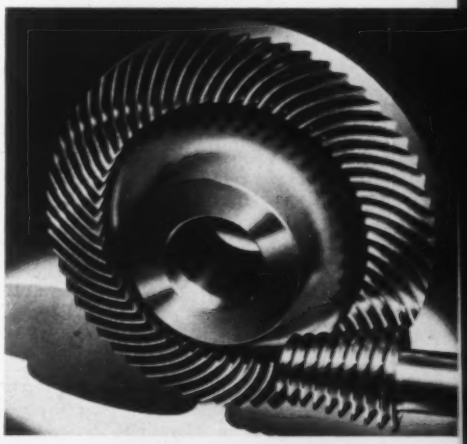
The manufacturer finds that this new concept in gearing presents no fundamentally new problems. The manufacturer's equipment investment generally can be confined to the cost of converting standard hobbers, thread mills, and thread grinders to spiroid use. The inspection equipment is the same, for the most part, as that used on other skew-axis gearing. Because of their relative insensitivity to mounting errors, spiroid gears present fewer problems in final assembly.

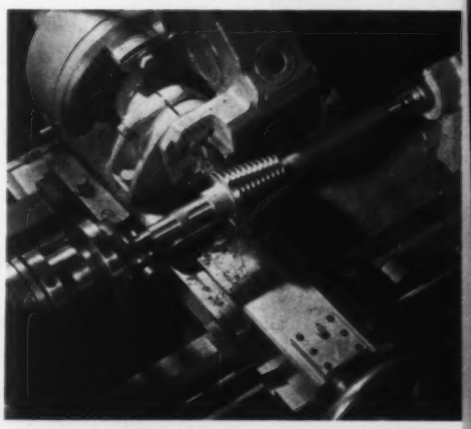
Because of the new design opportunities and the manufacturing advantages the consumer can expect a more reliable product at a more reasonable cost.

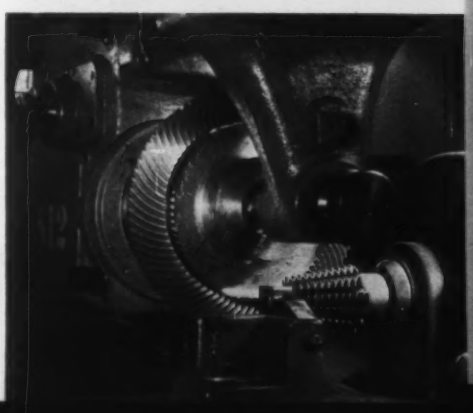
Spiroid-gear design is a relatively simple process when used in conjunction with standard proportions. Insight has been gained in the area of tooth-mesh force characteristics and the types of bearing mountings that are accordingly appropriate. A unique application of the principle of conjugate gear-tooth action enables the spiroid gear to use its lubricant to greater advantage. As a result, spiroid gears have longer life and more reliable service.

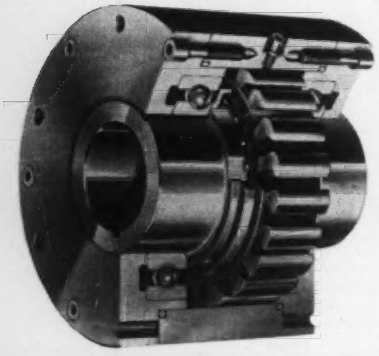
The versatility of the gear design, the wide range of usable gear materials, and the systematic comprehensive testing program, clearly indicate new horizons on skew-axis power transmission.

Spiroid gearing is a newly patented development in the field of skew-axis gearing. *Top,* spiroid pinion and gear; *center,* spiroid pinion thread-milling process; *bottom,* spiroid gear-hobbing process. (57—A-162)









High-speed outer-race overrunning clutch (57—A-166)

The Sprag-Type Overrunning Clutch.....57—A-166

By R. L. Daniels, Assoc. Mem. ASME, Formsprag Company, Van Dyke, Mich. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

An overrunning clutch is a clutch that drives in one direction of rotation, but will not drive in the opposite direction. The sprag-type overrunning clutch is the most advanced type of overrunning clutch. It provides high torque capacity, high overrunning speeds, no measurable backlash, and practically noise-free operation in the smallest space.

Several factors—gripping angle, Hertz stress, and change in gripping angle—are discussed in relation to design considerations for sprag-type clutches.

Sprag energizing, to provide the feature of "no measurable backlash" is considered. Three methods of energizing sprags are outlined. The PV, or pressure-velocity factor, is also considered.

A discussion of commercially available clutches is also presented.

Applications of Sprag-Type Overrunning Clutches.....57—A-165

By W. T. Cherry, Formsprag Company, Van Dyke, Mich. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Sprag-type clutches are being used increasingly for overrunning, backstopping, and indexing purposes.

Overrunning applications are those which encompass the following conditions: In one phase of a mechanical cycle, the clutch will transmit torque; in the other phase of the cycle, the driving member will either come to rest or reduce speed, while the driven member continues to rotate.

The term "backstop" or "holdback" refers to an application where the function of the clutch is to serve as a counter-rotation holding device.

Indexing consists of intermittent unidirectional rotary motion, with the clutch transmitting power in one direction and freewheeling in the other.

Selection of the proper sprag-type clutch for a specific application involving any of the three afore-mentioned basic functions requires a review of the following factors: Maximum torque to be transmitted, maximum overrunning speed, maximum driving speed, type of lubrication, mounting characteristics, environmental conditions, and shock.

Specific applications of sprag-type clutches for unidirectional drives, speed-differential uses, inertia dissipation, and starter applications are presented. These are discussed in detail and other overrunning applications are touched upon.

A New Method for Producing Continuously Adjustable Gear Ratios.....57—A-146

By V. W. Bolie, Iowa State College, Ames, Iowa. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

A device capable of providing continuously adjustable speed ratios has long been needed. Except for convenience in providing a few standard ratios, the conventional gear box has little to offer. The number of available ratios is severely limited and there is little or no regularity in the selection process. Other variable speed drives are the rotary amplifier, the variable speed servomotor, the variable pulley system, and wheel-and-disk apparatus—all of which are continuously variable in control but suffer in accuracy and load capabilities.

A new method for providing continuously adjustable gear ratios is described. The method makes use of differential gears and speed reducers in a regular and systematic manner to provide gear ratios which can be adjusted easily with levers or electrically switched clutches.

One of the most interesting features of the described methods for producing continuously adjustable gear ratios lies in ease of adjustment. The decade gearbox described in the paper permits any one of 1000 speed ratios to be selected simply by positioning three 10-position levers or three 10-position electrical switches.

The binary gearbox permits any one of 1024 speed ratios to be selected by appropriate positioning of 10 two-position levers or 10 on-off switches. This ease of adjustment makes the apparatus a convenient accessory for production and model-shop machines.

The systems described here can be elaborated to give a specified gear ratio to any degree of accuracy.

These gearboxes would be particularly useful for lathes, coil winders, gear hobbers, milling machines, rate-gyro testing tables, tonewheel audio-frequency generators, and wind-tunnel blower drives. The recent trend toward automatic fabrication techniques provides an interesting possibility of using them in conjunction with a punched-tape or punched-card control system. It would be a relatively simple matter to command the gear-ratio adjustments with electrical signals from tape or card readers.

Product Development—From Research to Production, Part 1, Research Cracks the Taste Barrier.....57—A-147

By A. M. Rockwood, Assoc. Mem. ASME, Battelle Memorial Institute, Columbus, Ohio. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Estimates indicate that hundreds of product-development projects are abandoned prior to production and that only one in ten new products survives to become profitable. The following suggestions for reducing the mortality rate of such projects are presented:

1 Product-development programs should be initiated only if careful analysis indicates that the profit potential is great enough to justify their cost.

2 The product-development effort should be planned carefully with a well-defined time schedule and appropriation and should be subjected to periodic reappraisals.

3 Product development should be carried out as a team effort in which research and development, sales, and manufacturing share the responsibility.

4 Management should be ruthless in dropping projects as soon as they fail to show sufficient economic or technical promise.

Details for the determination of a product's profit potential are given. In a discussion of development-program planning, evolution of a design concept, evaluation of the design concept, prototype design and evaluation, and production prototype design and evaluation are studied.

Most of the essential elements necessary to product-development success were present in the "tea-maker" story.

The National Restaurant Association and the Tea Council joined forces and decided to proceed with a research program having as its objective the development of suitable tea-making equipment.

Design specifications were formulated. The following requirements, among many others, specified that the proposed

equipment should: Generate its own boiling water; be able to produce hot and iced tea; be simple to operate; give a continuous flow of tea and be of ample capacity; and be as automatic as possible.

The state of the art in the United States and the British Isles was determined. Literature research indicated the use of freshly brewed tea concentrate for making hot and iced tea. The value of boiling and the significant temperature of the water for tea-making were studied.

With a thorough background and several leads, the research and development team formulated a preliminary design concept for a batch-type process. One of the early concepts featured twin-concentrate reservoirs. Design reappraisal tests were made and as a result the brew-water boiler and twin-concentrate reservoir, concentrate cooling and heating coils, the metering pump, and some complex valving were eliminated. A new tea-maker was developed.

Principles having been established and demonstrated, the team proceeded to design a prototype tea-maker. This one would approximate in size, styling, materials of construction, methods of fabrication, and components a machine which might be considered for production. The machine was designed so that it could be serviced completely from the front and was fabricated from stainless steel in accordance with the stated preferences of the restaurant-industry representatives.

With design objectives achieved, the patent application filed, and machine performance in limited field tests confirmed, the research staff had completed their assigned task.

Part 2, The Tea-Maker From Prototype to Production.....57—A-145

By V. K. Viitanen, Mem. ASME, Food Machinery Corp., Hoopeston, Ill. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Although the tea-maker prototype appeared to meet desired specifications, its operation suggested some changes. The design for the preproduction model was influenced by two facts: Changes suggested by the operation of the research prototype; and changes to reduce cost of constructing the preproduction prototype.

In order to gain further experience and to establish market information, it was decided that 25 field-test units would be constructed. Since the final design would be influenced greatly by the results of the contemplated field-test program, it was decided not to invest substantially in tooling. The design had to utilize some tooling and be adaptable to semiproduction-type fabrication.

Design specifications called for the following changes:

1 The accessibility and serviceability of the unit were improved.

2 The valve design was changed to reduce the amount of run-out after the valve was closed.

3 The suspension and drainage of the pyre reservoir was improved.

4 For improved metering, the orifice assembly was made an integral part of the infuser.

5 The boiler and the heater were reduced in capacity.

6 The cabinet top was contoured to conform with required drainage regulations imposed by city plumbing codes.

7 The reservoir cover was redesigned for proper drainage.

8 For greater accuracy, flexibility, and for reduced costs, an electrical timer was incorporated in the redesign replacing a mechanical timer.

9 The spray head, base, and the side and top enclosure parts contributed mostly to the appearance of the unit. Since it was felt that the shape of these parts may change in the final evaluation, it was decided not to use stainless for it necessitated expensive tooling. Yet, to gain market appraisal of appearance, these parts had to use complex surfaces. The use of molded fiberglas permitted this, with minimum tooling costs.

For reasons of simplification and reduced costs, numerous minor changes were made. Some of them were:

1 Standardization of valve design to use similar parts for all three valves.

2 The drain pan was made from perforated material.

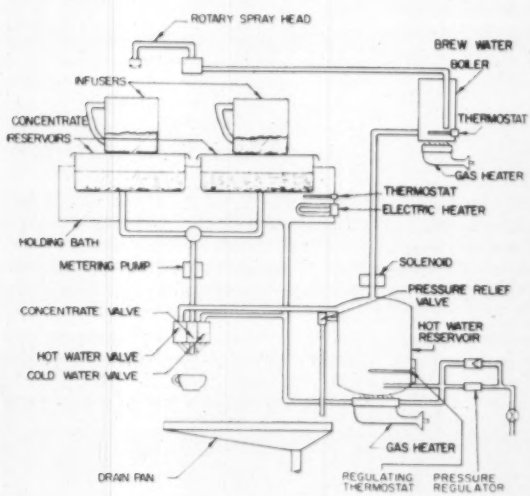
3 The heater and control elements were mounted in the same plate.

4 The valve-operating mechanisms and linkages, in general, were made from stampings or designs easily fabricated.

5 Supporting frame and tank were made a weldment.

The first unit was available for field evaluation by the end of March, 1958. It was agreed that the field-test program must establish the following: Effectiveness of mechanical operations, performance, operator acceptance, quality of the end product, ease of installation and servicing, life expectancy of the working components, ease of cleaning, and appearance. Details of the field-test program are presented.

Tea-maker, *below,* preliminary design concept of a twin-reservoir tea-maker (57—A-147). Production prototype tea-maker, *right,* provides both hot and iced tea automatically. Tea-maker delivers at least 200 cups of tea per hour, requires a minimum of maintenance. (57—A-145)



Instruments and Regulators

Single-Vane Hydraulic Servomotors and a Hydraulic Damper.....57—A-217

By D. V. Stallard, Feedback Controls, Inc., Waltham, Mass. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

In the last decade, the demand for servomechanisms with increasingly better performance has stimulated the development of improved components, such as electrohydraulic control valves with fast response. In many airborne fire-control systems, the servomotors for positioning the radar scanner must be capable of fast scanning motion and smooth operation at very low speeds. Instead of utilizing the customary electric servomotors, some radar scanners have special valve-controlled hydraulic servomotors with higher acceleration, wider speed range, and larger power-to-weight ratio.

One type of hydraulic motor has a single vane and is coupled directly to the antenna gimbal without gearing, so as to drive it through a limited angle, such as ±90 deg; clockwise rotation occurs when the four-way control valve admits oil to the right-hand motor port. For smaller angular rotation, a motor with two diametrically opposite vanes may be used. In contrast to conventional piston-motors, a single or double-vane motor has the advantages of lower starting-pressure, smoother operation, and elimination of gearing.

Because manufacturers of radar scanners for military aircraft are increasingly engaged in developing and applying hydraulic antenna drives, there is need for a widespread understanding of how best to design a single-vane hydraulic servomotor. Such a motor should have minimum friction, internal leakage, and weight. If the load is chiefly an inertia, the main dynamic problem is the mechanical resonance of the motor with its load, because the resonance tends to cause instability of the closed-loop system. In order to attain the highest practicable value of mechanical resonant frequency, the design of the servomotor must minimize the oil compliance, line compliance, and particularly the mechanical compliance, as defined in this paper.

The paper describes the analytical and experimental results obtained from building two hydraulic servomotors for an airborne radar scanner, and also an unusual hydraulic damper. Because a very fast frequency-response of the scanner was desired, much of the development effort was aimed at achieving the highest resonant frequency of the motor, consistent with a reasonable weight and cost. The hydraulic damper was developed to damp the unstabilizing motor resonance, so as to make possible a fast closed-loop system without reducing its torque constant.

A New Type of Hot-Element Directional Anemometer....57—A-197

By Kamal-Eldin Hassan, Assoc. Mem. ASME, University of Cairo, Giza, Egypt. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Many types of yawmeters have been made and used to measure the directions of fluid velocities. There seem to be, however, very few types of instruments which can be used for measuring, simultaneously, both the direction and magnitude of fluid velocities. The new type of hot-element anemometer described in this paper can be used for such measurements. It can be used in small enclosed spaces.

Three different constructions of the instrument were made and tested. In all these constructions the sensitive element is a thin platinum tape which is heated electrically and placed across the direction of the flow investigated. For a given position of the tape relative to a flowing fluid, the heat dissipated depends on the fluid velocity. Further, for a given flow velocity, the heat dissipated from the platinum tape depends on the angle of incidence which the tape makes with the direction of flow. The principle just outlined was used to develop the present type of anemometer which will be referred to as the "hot-tape anemometer."

The electric circuit used in connection with the hot-tape anemometer was a simple Wheatstone bridge similar to that used with hot-wire anemometers working at constant resistance; i.e., constant temperature.

The hot-tape anemometer is quite accurate. Experiments have shown that it measures the velocity with an error of less than 1.5 per cent. With one construction it was possible to determine the flow direction with a maximum error of ±0.5 deg. Better accuracies are expected with more refined methods of manufacture.

A New Hydraulic Servo Valve for Pulse-Length-Modulation Operation.....57—A-128

By J. E. Gibson, Assoc. Mem. ASME, Purdue University, Lafayette, Ind.; F. B. Tuteur, Yale University, New Haven, Conn.; and T. J. Mapes, Assoc. Mem. ASME, Eastern Industries, Hamden, Conn. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The basic principle in the pulse-length-modulation (PLM) mode of operation in order to achieve a certain hydraulic flow, involves the valve port not opened a given distance, proportional to an electrical signal, but rather thrown wide open and held open for a period of time and then closed. The average or smoothed flow of the pulses of oil will then be proportional to the magnitude of the input signal. The larger the amplitude of the input signal, the longer will be the length of time that the valve is held open.

A list of the advantages of the PLM mode, some of which follow, is presented. The torque motor or electric actuator of the valve may be optimized for maximum force per ampere. In the conventional valve, the flow gain is usually reduced at small signal amplitudes. This is not true in a PLM valve. Small signal sticking may be eliminated, since in a sense the PLM mode provides a massive valve dither.

Test results on proportional valves are discussed. Encouraging results indicate that PLM mode improves the operation of valves designed for proportional operation. The PLM mode sacrifices a small gain factor but yields in return an ideal frequency response.

A single-stage (PLM) valve and the response of such a valve are discussed.

The disadvantages of the PLM mode are noted, but the method, nevertheless, appears to provide an advance in the hydraulic control art.

Steady-State Axial-Flow Forces on Pneumatic Spool-Type Control Valves.....57—A-129

By Tsun-Ying Feng, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

In designing a high-performance control valve for pneumatic servo systems or similar applications, it is important for engineers to know the force required to operate the valve. Since most compressible fluids of pneumatic systems have relatively low density compared to the petroleum-base oil in hydraulic systems, pneumatic flow forces on the control valve have been considered negligibly small as compared with hydraulic flow forces. This assumption, however, overlooks the comparatively large velocity vector of the compressible fluid passing through the valve-metering orifice. This paper proves, with the experimental evidence, that pneumatic flow forces are comparable to hydraulic flow forces. The momentum theory is used to determine the steady-state axial-flow

forces on a pneumatic control-valve spool, caused by the compressible fluid passing through the sharp-edged orifice. The experimental results compare favorably with the theoretical calculations for valve displacements of 0.005 in. and less at supply pressures not exceeding 500 psig. Pneumatic flow forces as compared with hydraulic flow forces on the same valve spool are higher in the unchoked-flow regime $\left(\frac{P_{down}}{P_{up}} > 0.528\right)$ but lower in the choked-flow regime $\left(\frac{P_{down}}{P_{up}} \leq 0.528\right)$.

Interpreting Dynamic Measurements of Physical Systems.....57—A-103

By Sidney Lees, Instrumentation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME*, available to Oct. 1, 1958).

Background concepts are developed for the interpretation of dynamic measurements. General objectives for a dynamic-measurements program are discussed together with suggested criteria for selecting a test method. A generalized concept of the linear system is developed that has its quantitative form in the idea of the multicoupled operating system with several inputs and outputs. Several schemes to represent the parameters and coefficients of the performance equations associated with the multicoupled operating system are given, according to the test procedure. A general discussion is included of the experimental limitations bounding the interpretation techniques.

Part 2 is the second of a series of papers on interpreting dynamic measurements. A scheme is proposed to classify the testing and interpretation of physical systems into six categories: Derivatives method, steady-state frequency method, standard curves method, indirect frequency method, random input method, and combination method. The basis for each method is developed together with a discussion of techniques and limitations.

Reproducibility of a Pen-and-Chart Type of Recording Instrument Under Dynamic Conditions.....57—A-209

By D. H. Tsai, Assoc. Mem. ASME, and E. W. Hogue, National Bureau of Standards, Washington, D. C. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

There exists today a large group of instruments which record the measured quantity directly by means of a pen writing on a recording chart. This type of instrument has the important advantage of giving a graphical record of the variation of the measured quantity with time. However, because of the relatively large inertia and damping of the recording mechanism, the response of the instrument is usually fairly slow, and the recorded information is sometimes subject to very large dynamic errors. Also, because of the differences in construction or adjustment, the torque and response characteristics of different instruments (even of the same make) may be different, so that their results are not necessarily comparable. Finally, because the torque and response characteristics of a given instrument may be affected by environmental and operating conditions, it is sometimes difficult even to compare readings from the same instrument.

The general effects of inertia and damping on the dynamic characteristics of instruments are well known. In the case of the pen-and-chart type, however, the problem of analyzing the dynamic response is difficult because very little information exists in the literature on the nature of friction between the pen and the chart. This difficulty is further complicated by the fact that there are a variety of pens, inks, and charts which may be used in different combinations. Because of these difficulties, and because of the relatively large dynamic errors common to this type of instrument in high-speed measurements, it is doubtful that a detailed analysis of the problem of error of a "representative" instrument will be of much value. Nevertheless, in many applications the changes in measured quantity occur fairly slowly, or the nature of the measurement may be such that the dynamic errors are not of primary consideration. In these cases, recording instruments of this type can often be used to advantage if their reproducibility is first thoroughly ascertained.

This paper summarizes the results of a recent experimental investigation conducted at the National Bureau of Standards on some of the problems of reproducibility connected with the use of an instrument of this type. The work was limited to the study of (*a*) the effects of environmental and operating conditions on the response of the recorder, and (*b*) the general problem of calibration under dynamic conditions. The response of the recorder was evaluated in terms of the deflection of the recording mechanism under the action of a pulse input of a known duration. The response obtained by this method proved to be a sensitive measure of the dynamic characteristics of the recorder, and it was found that the response of two similar recorders to an arbitrary forcing function could be made closely the same by suitable adjustment in each recorder so as to make their response to a pulse function the same.

In this investigation, the main purpose has been to determine the operating conditions and necessary adjustments which would insure comparable results from two similar recording instruments. No attempt was made to determine the dynamic errors or to improve the dynamic characteristics of these instruments. Likewise, the problem of calibration under static condition was not considered.

The scope of this investigation was therefore rather limited. Nevertheless, it is believed that much of the information presented could be applied directly to other instruments equipped with similar pen-and-chart mechanisms. The method of approach was, of course, general, and could be adapted to the study of other types of recording instruments.

Fluid Meters

Subcritical and Critical Flow Through Straight-Through, Elbow, and Tee A-N Fittings and Sharp-Edged Orifices at Elevated Temperatures.....57—A-60

By A. L. Ducoffe, J. R. Bennett, and C. G. Ray, Georgia Institute of Technology, Atlanta, Ga. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

This paper presents the results of an investigation of the flow through straight-through, elbow, and tee A-N standard fittings at negligible approach velocity with approach temperatures up to 1100 F and head pressures up to 60 psia. The element pressure ratio, i.e., the ratio of downstream to upstream static pressure across the test element, was varied between 1.0 and approximately 0.25. Empirical equations for the subcritical and critical flow regimes are derived for the rate of weight flow as a function of element pressure ratio, flow area, and approach temperature and pressure. Empirical equations for a given geometry are derived for a flow factor which is shown to be a function of pressure ratio only in both the subcritical and critical regions. In addition, previous work at room temperature on the flow through sharp-edged orifices in the subcritical and critical regimes has been extended to include a variation of approach temperature up to 1100 F.

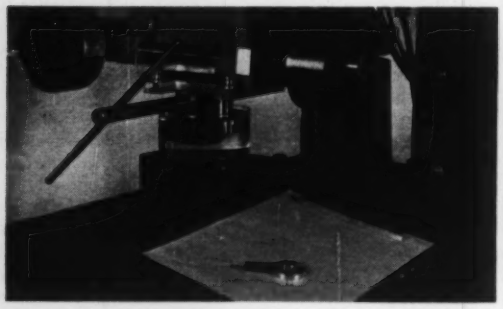
Metal Processing

Machinability of High-Strength Gray Cast Irons.....57—A-239

By I. Ham, University of Wisconsin, Madison, Wis.; J. R. Roubik, Mem. ASME, and J. P. Bunce, Mem. ASME, Kearney and Trecker Corporation, Milwaukee, Wis. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

An analysis of the machinability of high-strength gray cast irons, similar to ASTM specification A 48-48 Class-40, from nine midwestern foundries with a general-purpose, cast-iron-cutting grade of carbide is given. Tool force, energy, and power variations for the several cast irons over a range of speeds and feeds are depicted graphically.

Individual and average tool-life values and curves obtained in tool-life tests as well as types of wear encountered are presented. For shop application, a general production-rate tool-life chart for turning this class of cast iron at a fixed depth of cut is shown. Since examination of these cast irons showed no great differences in microstructure, an attempt has been made to arrive at an empirical correlation between chemical composition and machinability in terms of tool life.



Close-up view of test specimens lowered into glass dish containing clear butyl stearate. Typical test specimens are shown on writing board. (57—A-160)

A Method for Studying the Behavior of Cutting Fluids in Wear of Tool Materials.....57—A-160

By L. V. Colwell, Mem. ASME, University of Michigan, Ann Arbor, Mich. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Refinements of design and instrumentation in a new friction and wear machine result in some new types of information which show promise of extending knowledge of the mechanisms of friction, lubrication, and wear. Provision has been made for varying normal load linearly with time and oscillating it between preset values. There is continuous recording of both the normal load and the friction reaction. Continuous recording at oscillating normal loads has discriminated sharply between lubricant additives. Close control of test conditions in wear studies has made it possible to identify high residual compressive stresses produced in finish grinding of cutting tools.

Behavior of Cutting Fluids in Reaming Steels.....57—A-168

By L. V. Colwell, Mem. ASME, and Henrik Branders, University of Michigan, Ann Arbor, Mich. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

The subject matter of this paper is the result of an initial attempt to develop a combination reamer and burnishing tool. Preliminary calculations indicated that only a very little interference between a burnishing element and the wall of the hole would be required to produce a plastic flow of the metal, and thus result in burnishing providing adequate lubrication could be achieved. Preliminary tests were made with improvised burnishing tools; the torques were measured with a range of lubricants and compared with similar torque measurements for reaming the same materials. This information indicated that effective lubricants were very important not only for burnishing but also for reaming. Therefore it was decided to explore this problem further, particularly in connection with reaming.

The only reference to this topic in the literature involves a Russian research report. The report makes some reference to torque requirements but deals principally with variations in hole size as related to the reamer size. The principal conclusion of the report is that the "gap" between hole size and reamer size is due to wear by "dust particles of metal" between the wall of the hole and the margin of the reamer. This observation does not appear to be consistent with the preliminary results referred to above. Therefore it was decided to examine not only the torque requirements but also surface finish and hole size for a range of work materials, lubricants, tool condition, and size of cut.

Heat Transfer

An Experimental Investigation of Film Characteristics in Horizontal Annular Two-Phase Flow.....57—A-144

By H. N. McManus, Jr., Mem. ASME, Cornell University, Ithaca, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Annular two-phase flow in a horizontal tube was established by injecting water through an annular slot in the tube wall into a fully developed turbulent air flow. The film-profile dimensions, the liquid-disturbance height, the two-phase pressure drop, and the extent of film establishment were measured. The air Reynolds number was varied from 75,000 to 125,000. Water flows up to 0.7 lb per sec were used. The effect of flow rates upon liquid surface-disturbance character was examined visually and photographically. The profile dimensions throughout the tubes were found to be sensitive to air rate. The liquid rate varied the film depth only in the lower half of the tube. Disturbance height was found sensitive to the air rate and the liquid depth. The pressure drop before the establishment of steady-state conditions was sensitive to the inlet-film thickness. Film establishment exhibited a similar dependence. Photographic examination of the film-surface characteristics showed a dependence upon water rate as well as air rate. A correlation was obtained for the film thickness in the upper two thirds of the tube.

Blowdown and Charging Processes in a Single Gas Receiver With Heat Transfer.....57—A-137

By W. C. Reynolds and W. M. Kays, Mem. ASME, Stanford University, Stanford, Calif. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Gas blowdown and charging processes are generally analyzed on the basis of an adiabatic thermodynamic process. In most such processes of technical interest there is a considerable amount of heat transfer between the gas and the container walls, and in some applications heat capacitors are deliberately inserted in the container to control temperature or store thermal energy. In this paper the general problem of blowdown and charging is considered, including the effects of heat transfer to or from container walls or inserted heat capacitors. An experimental investigation of blowdown with heat transfer is described, and it is shown that the results correspond very well with the analysis.

Unified Treatment for Thermal Radiation Transfer Processes—Gray, Diffuse Radiators, and Absorbers.....57—A-34

By B. Gebhart, Assoc. Mem. ASME, Cornell University, Ithaca, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

A point of view and method of analysis of thermal radiation energy-transfer processes are presented. The net rate of loss for any given surface is analyzed. Absorption factors are defined and convenient relations between such factors are proved. The simplicity, convenience, and generality of this method of analysis are demonstrated by applying it to a general radiant environment with and without absorbing and emitting media between the surfaces and to environments consisting in part of special types of surfaces.

Heat-Transfer and Pressure-Drop Characteristics on Internal Finned Tubes.....57—A-47

By E. C. Brouillette, Lockheed Aircraft Corporation, Burbank, Calif.; T. R. Mifflin and J. E. Myers, Purdue University, Lafayette, Ind. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

It was the purpose of this investigation to determine the effect of a type of internal fin on the heat-transmission and pressure-drop characteristics of copper tubing. The fins were produced by cutting 60-deg, V-shaped notches on the inner surface of five specimens of tubing. The number of notches or fins varied from 8 to 32 per in. of length, and the ratio of fin height to tube diameter ranged from 0.009 to 0.050. The measured values of heat-transfer coefficients for the finned tubes were from 10 to 100 per cent greater than coefficients measured on a plain tube. Friction factors were also greater for the finned tubes by amounts ranging from 15 to 400 per cent. The results indicate that fin height has a greater effect in increasing the heat-transfer coefficient than the number of fins.

Radiant Heating of Transparent Materials.....57—A-51

By R. Gardon, Mem. ASME, and E. R. Michalik, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

An analytical solution is presented for the time and position-dependence of temperatures in transparent sheets heated by thermal radiation. The results are exhibited in dimensionless graphical form and their physical significance is discussed. In particular, comparisons are made between the heating of transparent and opaque materials and between materials in the form of sheets, or slabs of finite thickness, and semi-infinite solids. The results are illustrated by an example. This considers temperature distributions in glass plates during initial stages of heating in a furnace.

Prediction of the Pressure Loss and Density Factors for Two-Phase Annular Flow With or Without Heat Generation.....57—A-50

By J. C. Westmoreland, Assoc. Mem. ASME, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

A simple analysis is presented for predicting pressure loss and density factors for two-phase, one-component annular flow with and without heat generation. All four combinations of laminar and turbulent flow in both the annulus and core are considered. The analysis is based on assumed velocity profiles and matching velocity, and shear stress at the liquid-vapor interface. The theory is found to compare favorably with experimental results on both vertical and horizontal sections. The application of the theory to natural circulation steam generators is also presented.

The Transient Response of a Two-Fluid Counterflow Heat Exchanger—The Gas Turbine Regenerator.....57—A-135

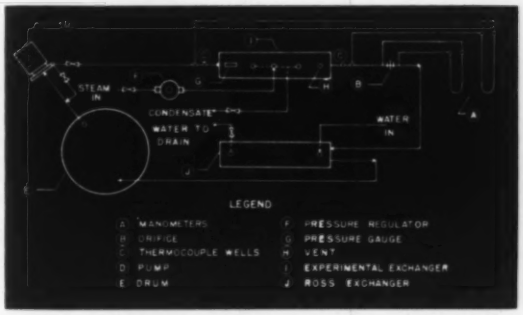
By R. M. Cima, Mem. ASME, and A. L. London, Mem. ASME, Stanford University, Stanford, Calif. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Some solutions for the transient behavior of a two-fluid direct-transfer counterflow gas-turbine regenerator, obtained experimentally using an electrical analog system, are presented. While restrictions were imposed on certain parameters with the gas-turbine-regenerator problem in mind, these results, presented in nondimensional form, are also of limited use for other two-fluid exchanger problems. A set of seven independent nondimensional parameters is proposed for general use. These include the three commonly associated with the steady-state performance plus four additional parameters unique to the transient problem. The electrical analog system is described in the Appendix and the associated experimental uncertainties noted.

Hydraulic Analogy for Transient Cross-Flow Heat Exchangers.....57—A-125

By S. Juhasz, Mem. ASME, *Applied Mechanics Reviews*, Southwest Research Institute, San Antonio, Texas. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Steady-state, cocurrent, countercurrent, and cross-flow as well as transient cocurrent and countercurrent cases, respectively, and their hydraulic analogies have been described by this author and his coauthors. This paper is an extension of earlier work on the subject.



Line diagram of equipment used to determine the effect of a type of internal fin on the heat-transmission and pressure-drop characteristics of copper tubing (57—A-47)

Present analogy is related to a one-pass transient cross-flow heat exchanger with longitudinal heat conduction in one of the fluids and in the heat-transfer surface. The analogy is composed of vertical liquid bottles (memories) with liquid-level reading scales (input and output). The bottles are connected with capillaries (arithmetic units). Rotary valves (controls) are used to change the connection between the bottles in a predetermined way.

In this analogy, time corresponds to time in the prototype and is continuous. Space in the analogy is lumped, the liquid quantity in the bottles represents the quantity of heat in the heat exchanger, and a given bottle represents a lumped section of the hot-fluid, heat-transfer material, or the cold fluid. Liquid level corresponds to temperature, and cross-sectional area corresponds to specific

heat. Capillaries represent either heat conduction or heat convection. Movement of one of the several rotary valves of the first kind, with one step, stimulates the movement of the hot fluid relative to the heat-transfer surface, and movement of the rotary valve of the second kind with p steps represents the movement of the cold fluid relative to the heat-transfer surface. Here, p equals the number of spatial subdivisions in the x-direction. Nonlinearities due to variable specified heat, heat-conduction, and convection coefficients can be taken into account with bottles of variable cross sections (inserted templates) and with variable capillary constants (variable length capillaries).

The extension of the analogy from single-pass crossflow to multipass cocurrent crossflow is outlined. The possibility of using an electric analogy, composed of capacitors, resistors, and synchromotor-operated electric switches, is considered. The educational aspects of this demonstrative analogy, beyond its practical use, are stressed.

Temperature Profiles in Radiation-Cooled Turbine Wheels. 57—A-122

By J. G. Bartas, Mem. ASME, General Electric Company, Lynn, Mass. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The steady-state temperature gradient in a turbine wheel generally depends on all three modes of heat transfer. Heat is transmitted by conduction along the wheel and by convection and radiation from the surfaces of the wheel to the surroundings. In many instances, where the amount of radiation is much less than the amount of convection, the radiant heat transfer can be neglected or considered linear with the temperature difference between the turbine wheel and the environment.

However, there are conditions where considerable error is introduced if the radiation is linearized. For example, the temperature profile in a turbine wheel operating in a rarefied atmosphere depends entirely on conduction along the wheel and radiation from the surface; convection can be justifiably neglected.

This radiation cooling problem is usually solved by numerical methods due to the nonlinearity of the equations and the relatively complex wheel geometry. It is possible, however, to obtain engineering estimates for the turbine-wheel temperature profile by idealizing the turbine-wheel geometry and solving the simplified equations. The analytical solution, plotted graphically, has the added advantage in that a minimum of effort is needed to determine the required answers. An analytical solution for the steady-state temperature profile in a radiation-cooled turbine wheel is presented in this paper.

Resistance Welding of Platinum-Ten Per Cent Rhodium Wire to Platinum Sheet. . . . . 57—A-118

By C. E. Moeller, Assoc. Mem. ASME, Midwest Research Institute, Kansas City, Mo. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

To measure temperatures of a sheet of platinum when exposed to high-velocity gases, a thermocouple was designed such that its thermal junction is well defined and in the form of a plane, parallel to and a known distance from the exposed surface. The junction is at the interface of the platinum sheet and a head of platinum 10 per cent rhodium, 0.040 diam, and 0.007 in. thick on the end of a 0.010-in-diam lead wire. It is mechanically produced by resistance welding, the optimum welding parameters being determined by metallographic examination of the weld specimens.

The generation of heat at the weld surfaces stress-relieves the deformed platinum crystals of the cold-worked sheet. Thus the relative magnitudes of the heating effect can be determined by the size of the region of the annealed platinum crystals in the polished and etched cross section of the weld specimen. Performance data currently available consist of the static calibration of a number of the thermocouples. Results from the Diamond Ordnance Fuze Laboratories, Washington, D. C., indicate reproducibility of the elements within 3.5 microvolts at 960 C.

The Effect of Flow Distribution on Heat-Exchanger Performance. . . . . 57—A-112

By W. H. Comtois, Assoc. Mem. ASME, Combustion Engineering, Inc., Windsor, Conn. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

A method for calculating the effect of flow distribution on the performance of heat exchangers when the distribution is two-dimensional is presented. An exact solution is presented for the special case of zero capacity-rate ratio and an example worked out in detail. A less exact method, with examples, is presented for attacking the problem for any value of the capacity-rate ratio for countercurrent and parallel-flow exchangers. A physical reason is presented for the behavior of exchangers operating with flow streams which do not have one-dimensional velocity profiles. Special emphasis is placed on the effect that flow distribution has on the design of high-effectiveness heat exchangers.

An Investigation of Effective Thermal Conductivities of Powders in Various Gases. . . . . 57—A-110

By R. G. Deissler, Assoc. Mem. ASME, and J. S. Boegli, Lewis Flight Propulsion Laboratory, National Advisory Committee on Aeronautics, Cleveland, Ohio. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

An experimental study was made to determine the effective thermal conductivities of magnesium oxide, stainless steel, and uranium oxide powders in various gases. The gases included air, helium, argon, nitrogen, neon, and various mixtures of these gases. The variables investigated included temperature level, gas pressure, porosity, gas conductivity, and solid conductivity. A reasonably good correlation of the data was obtained by using the dimensionless group's effective thermal conductivity over gas conductivity, solid conductivity over gas conductivity, and porosity of the powder, although the effective conductivity may also be a function of the shape and arrangement of the particles. A solution for spheres in cubical array was obtained by relaxation and was in reasonable agreement with the data for porosities in the neighborhood of that for the spheres.

Local Laminar Heat Transfer in Wedge-Shaped Passages. . . . . 57—A-133

By E. R. G. Eckert, Mem. ASME, T. F. Irvine, Jr., and J. T. Yen, University of Minnesota, Minneapolis, Minn. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Heat transfer in noncircular passages recently has received increased attention in connection with various engineering applications, especially with nuclear-reactor technology. The present paper presents the results of calculations for heat transfer connected with steady laminar flow through ducts whose cross sections have the shape of circular sectors. Hydraulically and thermally developed flow is assumed. The temperature field, peripheral distribution of inner-duct surface temperature and of heat flux, as well as heat-transfer coefficients and friction factors, are presented for two boundary conditions: Peripherally constant heat flux and peripherally constant surface temperature, both with longitudinally constant heat flux. It is found that even average heat-transfer coefficients may be different by an order of magnitude for these two conditions. For this reason,

it is pointed out that solutions for a class of boundary conditions can be obtained by linear superposition of the results obtained for the two conditions mentioned.

Vapor Formation and Behavior in Boiling Heat Transfer....57—A-74

By R. A. Egen, D. A. Dingee, and J. W. Chastain, Battelle Memorial Institute, Columbus, Ohio. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

An experimental program was conducted to study the formation and distribution of vapor in a rectangular channel under boiling-heat-flux conditions at 2000 psia. In addition, the problem of preferential distributions was studied to determine its effect on the validity of the results of this program. Over the range of variables tested, there was no flow-rate effect, and the slip, where determinable, appeared to be constant. The void fraction is correlated with the quality and heat flux, in the vicinity of zero quality; the dependence upon heat flux decreases with increasing quality in this region. Inlet-temperature variation has no effect on the value of the void, providing the inlet temperature is below the temperature necessary for local boiling.

Effects of Tube Bundle-to-Shell Clearance on Pressure Drop and Heat Transfer in Shell-and-Tube Heat Exchangers.....57—A-49

By B. E. Short, Fellow ASME, and B. F. Treat, Mem. ASME, University of Texas, Austin, Texas. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Results reported here represent a study of the effect on heat transfer and pressure drop of the clearance between the tubes and exchanger shell for a small shell-and-tube heat exchanger. These results are primarily for the laminar-flow region although some are presented from the data for the transition and turbulent regions. The pressure-drop data are presented principally on the basis of the friction factor for flow across the tube bank.

The bypass channel friction factor for one of the tube bundles is shown as a function of the Reynolds number for this channel to indicate the region of departure of the bypass stream from laminar flow. The heat-transfer results are shown, for several tube bundles and several tube-bundle-to-shell clearances, in terms of the Colburn j-factor (except for the viscosity ratio) as a function of Reynolds number based on tube diameter, average maximum velocity of crossflow, and viscosity at average temperature; and also based on an equivalent diameter for flow across the tube bundle, average maximum velocity allowing for the bypass stream, and average of viscosities at terminal temperatures.

Heat Transfer to a Turbulent Boundary Layer Downstream of an Injection Slot.....57—A-36

By R. A. Seban, Mem. ASME, and H. W. Chan, University of California, Berkeley; and S. Scesa, Assoc. Mem. ASME, Aeronutronic Systems, Inc., Glendale, Calif. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Adiabatic wall temperatures and heat-transfer coefficients are presented for a turbulent boundary-layer flow of air over a flat plate downstream of the point at which air is injected into the existing flow. Normal and tangential injections were examined and the results compared to those of Wieghardt for approximately tangential injection. Free-stream velocities were below 125 fps so that effects of flow dissipation were not included. Mass rates of injection air flow ranged from zero to a value equal to that of the free-stream flow.

The results for the adiabatic wall temperature indicate a complicated dependence on the flow only partly accounted for in the correlation achieved. A postulate that the flow characteristics do not affect this temperature, so that the source can be idealized merely as a line source of heat, is not confirmed by these results. The results for the heat-transfer coefficient are far less affected by the changes in the flow, due to injection, and the results demonstrate that for a major region downstream of the slot these coefficients are close to those that exist for a turbulent boundary layer on a smooth flat plate.

Management

Project Control in Engineering Development.....57—F-2

By G. L. Thuering, Mem. ASME, The Pennsylvania State University, University Park, Pa. 1957 ASME Fall Meeting paper (multilithographed; available to July 1, 1958).

The Propulsion Wind Tunnel (PWT) of the Arnold Engineering Development Center (AEDC) was confronted with the necessity of providing a planning and scheduling system which would insure efficiency of operation. To solve the problem a system of project control was gradually developed, in its basic elements, within the PWT Division and was modified and extended to the present integrated control plan by the author. The final PWT control plan is described in this paper.

Power

Ultrasonic Testing of Large Rotor Forgings.....57—A-279

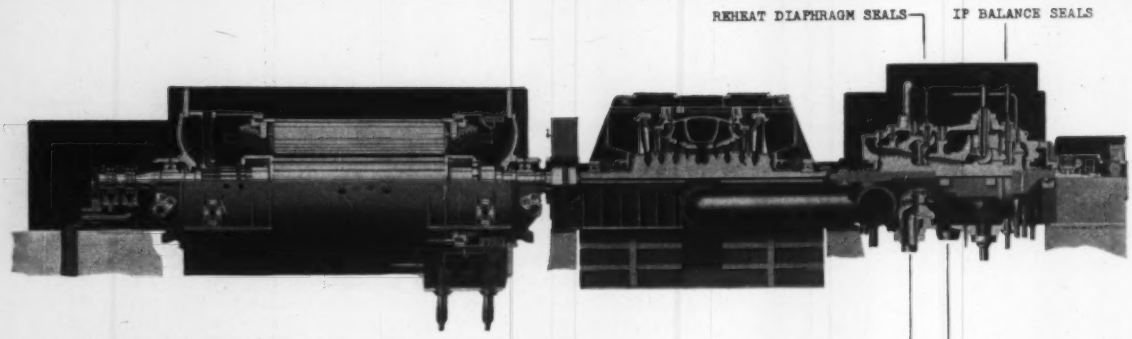
By S. Serabian and G. E. Lockyer, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Operating stresses in large steam turbine-generator rotor forgings have gradually increased in recent years, and the need, therefore, has grown for testing methods to determine the necessary forging quality. At present, the only nondestructive means for detecting internal imperfections in such forgings is by ultrasonic testing.

Forging quality has improved since ultrasonic testing was first introduced. In the early stages, discontinuities were comparatively large, with dense distributions. Today they are smaller and more widely scattered, and an appraisal of inspection techniques is advisable if ultrasonics is to continue to show the way toward further forging improvement.

This paper discusses the factors which influence the selection of the most suitable ultrasonic techniques for use in the nondestructive testing of large rotor forgings. It deals with the problem both theoretically and experimentally. Testing techniques for the initial forging inspection and the finished rotor assembly, and recent developments in these phases are also considered.

An ultrasonic inspection which will scan the interior of an object does not necessarily have the ability to detect the presence of discontinuities. Successful scanning and detecting involves consideration of a number of factors in order to decide the parameters of the proper testing equipment, as well as the proper testing techniques to be used. Due to the newness of the art, very few attempts have been made to study these important factors minutely. One such study is reported here; that of dispersion phenomena of discontinuities. Through this study, it was realized that the discontinuity does not act as a pure reflector but rather scatters or radiates the energy incident upon it with a dispersion governed by the diameter of the discontinuity and wave length involved. On



High-pressure and high-temperature 3600-rpm turbine driving modern supercharged hydrogen-cooled generator. A 150-mw reheat tandem turbine-generator unit. (57—A-188)

this basis, it was possible to explain the true role or influence of the testing frequency.

The study of the range of detectable discontinuity orientation, while primarily concerned with the inspection of wound generator rotors, and the limitations brought about by the geometric configuration of the coil slots, serves to illustrate from a practical standpoint the problems imposed by geometry and the extent to which dispersion of the discontinuity may affect the test results. An analysis of this type pointed out some shortcomings of certain testing techniques, and indicated the necessity for the development of additional tests. The teeth test used on wound generator rotors, and the technique of inspecting from the bore surface, which is applicable to both generator and turbine rotors, are two examples of such supplementary tests.

The trend toward better forging quality and the detecting ability of an ultrasonic test must go hand in hand.

As forging quality is improved, ultrasonic testing sensitivity should be increased to permit continuing quality comparisons.

Overspeed Problems of Reheat Tandem Turbine-Generator Units.. .....57—A-188

By C. L. Ringle, Mem. ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Today's high-pressure and high-temperature 3600-rpm turbines driving modern supercharged hydrogen-cooled generators present increasing ratio trends of power output to rotational inertia. Modern turbine designs, aimed at continually improving over-all performance, have presented amplified associated overspeed problems. The control of the turbine-generator-unit overspeed levels which are produced by the accelerating potential of large steam volumes stored in the reheater system and extraction heaters, including stored flashable condensate, is one phase of the overspeed problem. The other phase is holding the speed rise of the unit below the trip-out level, following an instantaneous loss of capability load, so as to maintain an auxiliary power supply and eliminate resetting operations. This second phase problem can be divided into two types. They are: (*a*) The possibility of trip-out produced by high initial acceleration rates; and (*b*) the possibility of trip-out produced by the slow accelerating action of the pressurized high-pressure turbine section diaphragm-seal steam leakages.

On certain system arrangements, where a solenoid-actuated trip-out of all steam inlet controls is permissible following relay or circuit-breaker action, the initial acceleration problem is of no consequence.

The normal reasons for a solenoid-actuated trip-out are low vacuum, low bearing oil pressure, failure of turbine thrust bearing, and certain electrical system faults. All other trip-out causes should be minimized for maximum station operating efficiency.

This paper covers the general overspeed and trip-out problems for modern reheat tandem steam turbine-generator units and tabulates the increased acceleration potential of the newer units placed in service or being manufactured. The methods developed and incorporated by the author's company to cope with the load dump and associated overspeed problems are presented.

Progress in the Development of Steam Turbine-Generator Rotor Materials.....57—A-280

By D. R. Deforest, D. L. Newhouse, and B. R. Seguin, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Throughout the development of the large steam turbine-generator in this country, the fundamental importance of obtaining rotor forgings capable of withstanding high centrifugal stresses under various operating conditions has been recognized, both by the manufacturers of such equipment and by the forging producers. Increases in rotor sizes and stresses have been matched by improvements in forging quality and inspection methods, to such an extent that fractures of either steam-turbine or generator rotor forgings were virtually unknown over a period of many years.

Significant progress has been achieved in a rotor development program designed to produce generator rotors and low-pressure turbine rotors with improved ductility and resistance to brittle fracture at the operating temperatures for these components. The variables being investigated, the methods used in evaluating rotor properties and quality, and results obtained thus far are reported in this paper.

A Program for the Appraisal of the Tendency of Brittle Fracture in Steel Forgings.....57—A-262

By A. O. Schaefer, Pencoyd Steel and Forge Corporation, Philadelphia, Pa. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

A paper prepared over a year ago (see *Trans. ASME*, vol. 78, October, 1956, p. 1623) set forth the background and plans of a Task Group organized in Sub-Committee VI (Forgings), Committee A-1 (Steel) of the American Society for Testing Materials. The Task Group was organized because of three failures of turbine and generator rotors, the circumstances of which have been reported in the same volume and issue of *Transactions*.

The stated objectives of the Task Group were to "investigate the causes of brittle fracture in steel forgings, and to attempt to discover a means of appraising

the tendency or susceptibility to brittle failure in steel forgings." This paper is a report of the further progress of this Task Group, and a discussion of what might be expected in the future from such a project.

Computer Applications in Non-Nuclear Aspects of Ship Design... .....57—A-117

By William Heltzel, Newport News Shipbuilding and Dry Dock Company, Newport News, Va. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

Early in 1955, the Newport News Shipbuilding and Dry Dock Company acquired an analog computer containing 40 operational amplifiers with a commensurate amount of auxiliary equipment. Subsequently, the company began to investigate the feasibility of using a high-speed automatic digital computer for solution of problems which are not suited for an analog machine or which are better suited for a digital machine. In order to have an unbiased opinion of the need for such a machine, a firm of consultants was hired to make a survey of the plant and to make recommendations relative to the types of problems that were suitable for automatic computation, whether such problems were sufficient to warrant the procurement of a digital computer, and to recommend a type of computer that would suit their needs.

The development of the automatic computer section at this shipyard is outlined, followed by a discussion of the results of a questionnaire which was designed to ascertain the use that is being made of high-speed automatic computers in the shipbuilding industry in this country.

Development of High-Pressure Centrifugal Pumps for Controlled Circulation and Supercritical Steam Generators.....57—A-243

By R. E. Allen, Cameron Pump Division, Ingersoll-Rand Company, New York, N. Y. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

A brief review of some solutions to the problem of designing centrifugal pumps for controlled boiler circulation service and recent supercritical main boiler-feed pumps is given. Stuffing boxes in particular are discussed.

Conventional packing was replaced with floating rings in boiler circulating pumps, and this stuffing box improvement was incorporated later in the supercritical main boiler-feed pumps.

The boiler circulator was removed from the floor, its baseplate eliminated, and it was mounted vertically to move freely with the piping.

With the coming of irradiated hydrothene motor insulation, the boiler circulator was further improved by introducing the wet motor, stuffing-boxless type, eliminating all leakage and high-pressure injection equipment.

Design features on subcritical boiler-feed pumps were the basis of design references for the supercritical boiler-feed pumps. Casing gasket, bolting, stuffing box, and rotor dynamics problems were thus solved in an orderly manner.

The Propagation of Cracks and the Energy of Elastic Deformation.... .....57—A-189

By H. F. Bueckner, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Considerations in this paper deal with the change of strain energy and with the work of impressed forces during crack extension. It is assumed that the strains are small and that stresses and strains are correlated by Hooke's law.

The Griffith model of brittle fracture of elastic solids and the model by Irwin and Orowan for the brittle fracture of elastic-plastic solids predict the propagation of cracks on the basis of energy supplied by the work of externally impressed forces and by the change of strain energy. Previous discussions have neglected the three dimensional viewpoint and the body forces. Since the Irwin method of fracture strength analysis has become of increased interest, especially with respect to rotor fracture, a general analysis of energy supply is presented. The analysis uses Clapeyron's theorem and Betti's reciprocal theorem.

The energy available for crack extension comes from two sources: The work of the externally impressed forces and the change of the strain energy. The combined energy release from both sources is always positive; it equals the strain energy of the difference of the stress fields before and after crack extension. The difference field stays the same if the fields before and after crack extension are modified by subtracting from both of them the field of the uncracked specimen. The problem of crack extension is thus reduced to a study of the modified fields. These have no body forces; they show surface tractions at the crack surfaces only; these tractions are induced by the field of the uncracked specimen. The effects of different systems of impressed forces (e.g., one system with body forces, another with surface tractions) acting on the same body, can be compared with one another on the basis of the surface tractions, which the modified states display on their crack surfaces.

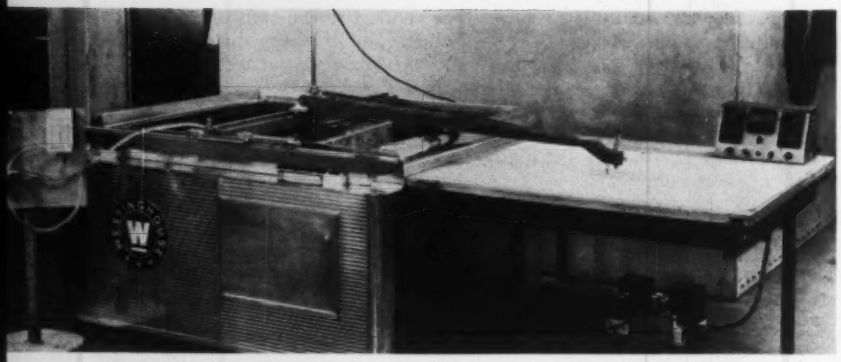
In addition to these general results, the following special statements can be made. When a crack extends under constant load, the strain energy decreases. However, the work of the externally impressed forces supplies twice the increment of strain energy and the surplus is available for crack extension. When a crack extends under fixed grips without body forces there is no work of externally impressed forces. The strain energy decreases, and the decrement is available for crack extension. The energy supply for crack extension under constant load is larger than the supply under the condition of fixed grips. However, the energy release rates (energy per unit area of crack extension) are the same at the onset of crack propagation, at least for certain cases of plane strain.

Application of the Griffith-Irwin Theory of Crack Propagation to the Bursting Behavior of Disks, Including Analytical and Experimental Studies.....57—A-249

By D. H. Winne, Assoc. Mem. ASME, and B. M. Wundt, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (multilithographed; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Results of bursting tests of large, bored, and effectively notched disks removed from long rotor forgings are presented. Most of the tests were conducted at room temperature. For the particular disk geometry employed, the net average tangential stress at bursting speed was as low as 25,000 psi for brittle behaving materials and as high as 77,000 psi for materials approaching ductile behavior. These correspond to 26 per cent and 92 per cent of yield strength, respectively.

The Griffith-Irwin theory of crack propagation is adapted to the calculation of G_c, fracture toughness, from notched-disk bursting-test results. It is shown that G_c from disk tests agrees with G_c obtained from slow notched-bend tests, and therefore appears to be a property of material, largely independent of specimen size. The actual magnitude of G_c permits the classification of forgings by the degree of their susceptibility to brittle fracture in the presence of discontinuities. G_c and the ratio K_{ys} of room temperature bursting strength to yield strength are found to correlate well with the material Charpy V-notch fracture appearance transition temperature. As the latter is reduced, G_c and K_{ys} are increased.



Over-all view of electrolytic tank analog including plotting table, following arm, and depth-control apparatus (57—A-120)

Electrolytic Tank Analog for Studying Fluid-Flow Fields Within Turbomachinery.....57—A-120

By R. P. Benedict and C. A. Meyer, Mem. ASME, Westinghouse Electric Corporation, South Philadelphia, Pa. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The electrolytic analog, taken in its entirety, is an instrument whose primary function is to provide solutions to problems encountered in various vector fields, such as may be described by a generalized Laplace equation. Some commonplace examples of Laplacian fields are to be found in the studies of electrostatics, heat transfer, and fluid flow.

The tank analog finds another equally important application when used as an aid in determining the design of electrical, heat-transfer, and fluid-flow apparatus. In this application, boundaries are moved until, by a cut-and-try process, satisfactory performance is achieved.

Because boundary conditions, necessary to solve Laplace equations, are very difficult to evaluate, none but the most elementary field problems can be solved by purely analytical means. Instead, numerical mathematical analysis (relaxation or iteration methods) has provided the usual means for solving Laplacian field problems. When using these methods, two serious difficulties are encountered. First, even with the help of digital computing machines, the solution is time-consuming because both methods require that boundary values be written. Furthermore, the complete field must be considered (i.e., rough values of the function must be assumed) and programmed to obtain a solution, despite the fact that interest may bear on a small portion of the field only.

In contrast with the above limitations the electric field analog makes available the completely relaxed solution at the turn of a switch; and only those portions of the field which are of immediate interest need be examined in detail. Furthermore, data from the analog are in a more accessible form; that is, flow lines may be simply constant voltage lines rather than a series of numbers from numerical methods, which must be cross-plotted before their significance can be known. Finally, boundary conditions are built into the analog solution (not programmed) through the use of properly constructed models.

A method is described for obtaining, by an electrolytic analog, the flow streamlines and velocity components throughout the fluid-flow field of a stream turbine. Following a brief historical review of the work pertinent to this study, equations are developed which describe the electric field within an electrolyte and the fluid field within a turbine. Electrical circuits are presented. Mechanical features are reviewed. Construction of analog models is described. A selected bibliography is given.

Railroads

Improving Rail Adhesion for Diesel Locomotives.....57—A-268

By P. V. Garin, Mem. ASME, Southern Pacific Company, San Francisco, Calif. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The problem of obtaining proper rail adhesion for locomotives has been with the railroads since the earliest days of their operation. The advent of the diesel locomotive with electric traction, rather than offering the solution, in some ways has aggravated this problem.

This paper covers some of the fundamental considerations involved in wheel-rail adhesion and suggests certain methods for improving this relationship. Laboratory and field tests of various antilubricants for improving rail adhesion are discussed. These tests include the commonly used sand as well as silica in its other forms. Methods for improving sanding devices also are suggested.

The development of the ultimate solution for the rail-adhesion problem with diesel locomotives will require the co-ordinated efforts of engine builders, equipment manufacturers, and the railroads. The tremendous savings in operating and maintenance costs available from improved methods for obtaining optimum rail adhesion under all circumstances should stimulate and accelerate these efforts.

Advancing Adhesion—Development and Test of a Chemical Formulation to Condition the Running Surface of Rail for Improved Wheel-to-Rail Adhesion.....57—A-130

By F. G. Fisher, Assoc. Mem. ASME, The Reading Company, Reading, Pa.; R. K. Allen, General Electric Company, Erie, Pa.; and G. W. Luvis, National Aluminate Corporation, Chicago, Ill. 1957 ASME Annual Meeting paper (in type; to be published in *Trans. ASME;* available to Oct. 1, 1958).

Chemical conditioning of rail running surface to overcome the effects of oil films is capable of producing a definite increase in locomotive adhesion. Extensive tests under operating conditions for more than a year have demonstrated its practicability and economy. Characteristics necessary to permit a chemical formulation to qualify for commercial use have been determined, and a practical method of application developed. The ultimate objective of application from the locomotive, as is done with sand, is being sought.

Notes on the Starting of Trains.....57—A-148

By Spyro Kyropoulos, Holloman Air Development Center, Alamogordo, N. M. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

An analysis is made of the natural lubricating factors which reduce the friction of steel against steel in railway operation. It is concluded that under ordinary conditions adsorbed films and particularly the always present iron-oxide layers are the most powerful lubricants. Water fosters their formation and restoration.

Hard "abrasives," on being crushed and comminuted, offer large fresh sur-

faces to act as adsorbents and sharp corners and edges to damage and penetrate the oxide layers.

The following suggestions for experimentation are derived:

1 Removal of the natural adsorbed films and their replacement with oxidation preventing more volatile and less effectively lubricating films by wiping devices containing volatile solvents, preferably for both water and oil.

2 Removal of the iron-oxide layer by reduction, preferably by applying a suitable galvanic potential.

3 Removal of water, water films, and other contaminants by application of chemically inert, water-soluble drying agents; e.g., salts, such as anhydrous sodium sulfate. The application of such salts might yield most benefits of the hard abrasives without their disadvantages (large wear, insolubility in water).

Testing of Railway Passenger Cars and Components.....57—A-111

By W. W. Seary, Jr., The Budd Company, Philadelphia, Pa. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The modern railway passenger car incorporates a great variety of features which contribute to the safety, comfort, and pleasure of the traveling public. The new designs for commuter service likewise are dedicated to the safety and comfort of the passenger, and incorporate facilities commensurate with the shorter travel distances.

Efficient and adequate design of the modern railway passenger car and its facilities is made possible by an accompanying program of testing that serves to eliminate errors and discriminates between choices in design procedures.

Structural testing both static and dynamic, in conjunction with functional testing of hardware, and electrical and mechanical components results in a successful end product.

A description of such tests is presented in this paper.

Mechanical Refrigeration in Railroad Refrigerator Cars..57—A-114

By B. E. Duff, Fruit Growers Express Company, Alexandria, Va. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

The modern railroad refrigerator car has evolved from the results of intensive research and numerous experiments in the art of railroad refrigeration. The loading space has been balanced with the bunker ice capacity; effective insulation is applied in floor, walls, and roof to suit the needs of the traffic to be handled; floor racks raise the load above the floor for improved air circulation through the ice around the load.

Cars built today are of all-steel construction with sliding doors having a 6-ft-wide door opening, air-circulating fans, side-wall flues, diagonal-slat floor racks, easy riding trucks, and a minimum of 4 in. of insulation.

A brief outline of the background, development, and service requirements of railway refrigeration is presented.

Mechanically equipped refrigerator cars were developed primarily to provide the lower in-transit temperatures required for satisfactory transportation of the frozen citrus-juice concentrates and other products of the rapidly growing frozen-foods industry. The first mechanically equipped refrigerator cars provided zero or below temperatures only.

Further research has developed today's "all-purpose" mechanically equipped car which is suitable for the transportation of both fresh and frozen commodities, providing either refrigeration or heat at controlled temperatures from zero to 70 F.

Satisfactory results have been obtained from the mechanically equipped refrigerator cars now in service, but there is need for technical improvements to simplify the refrigeration equipment, make it more compact, and to produce a more economical unit.

Design of an 8500-Horsepower Gas Turbine-Electric Locomotive for High-Speed Freight Service.....57—A-149

By F. D. Gowans, Mem. ASME, General Electric Company, Erie, Pa. 1957 ASME Annual Meeting paper (multilithographed; available to Oct. 1, 1958).

New, heavier, and more powerful gas turbine-electric locomotives were put into service on the Union Pacific Railroad this year. This is the third order for gas turbine-electric locomotives which this railroad has placed with the builder since 1951. Ten 4500-hp locomotives on the first order were delivered in 1952, and 15 essentially duplicate locomotives on a second order were delivered in 1954. During 1956 these 25 locomotives averaged 10,000 miles per month, hauling approximately 12 per cent of the Union Pacific System's total freight traffic that year. Operation of these locomotives has been confined largely to the territory between Ogden and Cheyenne.

The Union Pacific still has a large number of steam locomotives operating in this territory which they wish to retire. For this purpose they wanted a locomotive with more weight on drivers and a higher horsepower-per-ton ratio in order to handle high-speed long-distance freight.

All of these factors are embodied in the new locomotive. From the nose to the rear of the tender, it is designed to meet these requirements. It is 179 ft long, weighs 598 tons with the tender fully loaded, and rates 8500 hp. It has 828,000 lb on drivers and will handle a 5000-ton train at 17 mph on the 1.14 per cent grade from Ogden to Evanston. It is geared for a maximum speed of 66 mph and has 20 hp per ton of weight on drivers compared with 16 on the 4500-hp locomotive.

Numerous problems had to be solved in the design and construction of the locomotive and its power plant. Early results indicate success, although much more operating experience must be accumulated before the locomotive can be evaluated fully.

General arrangement and the turbine arrangement of equipment for the new locomotive are given. Mechanical parts for the platform and cabs, for trucks, and for the lifting arrangement are described. Operation of the system is also covered.

A locomotive of this weight and horsepower is best applied in high-speed, heavy, nonstop freight service over long distances. With its 24,000-gal fuel tender, it can pull a 5000-ton train from Los Angeles to Omaha, a distance of 1811 miles, with only two intermediate stops for fueling. Its high horsepower capabilities make it especially suited to the western divisions because it can maintain higher speed on the mountain grades.

8500-hp gas turbine-electric locomotive with fuel tender. It is 179 ft long, weighs 598 tons with the tender fully loaded. (57—A-149)

Applied Mechanics

High Order Accuracy in the Solution of Partial Differential Equations by Resistor Networks. 57—F-1

By H. G. Landau, Columbia University, New York, N. Y. 1957 ASME Fall Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to July 1, 1958).

In the practical solution of partial differential equations, very high accuracy is sometimes needed, particularly when the derivatives of the solution are the quantities in which we are interested. A procedure is given here for obtaining this high accuracy by a combined numerical and electric resistor-network method. The equation is first solved approximately on the resistor network; then the residuals in the corresponding finite-difference equation are evaluated numerically. These residuals are used as current inputs to the nodes of the network to obtain a correction to the first solution. If the errors in the first solution (including both experimental and lumping errors) are of the order of a few per cent, then the errors in the corrected solution will be of the order of a few hundredths of 1 per cent. The method makes possible accurate solutions without very stringent requirements on the precision of the resistors and other components of the electric circuit.

Further Studies of Stress Distribution in Rotating Disks and Cylinders Under Elevated-Temperature Creep Conditions. . . . . 57—A-91

By A. M. Wahl, Fellow ASME, Westinghouse Electric Corporation Research Laboratories, Pittsburgh, Pa. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

The analysis previously given for stress in rotating disks having central holes and under steady-state creep conditions is extended to cases where the radial and tangential stresses are equal over all or a portion of the disk, both constant and variable-thickness cases being considered. In addition, the solid rotating disk and the long rotating solid cylinder are treated, peak stresses above the elastic values being found under certain conditions. Charts are presented for determining ratios σ_{tm}/σ_{tav} between peak stress and average stress, for various diameter ratios, disk contours, and values of n in the power-function stress-creep rate relation. These indicate somewhat lower ratios of peak to average stress for the variable-thickness disks. Based on the theoretical results, curves of stress distribution are also worked out for several typical cases.

Effect of Curvature on the Hertz Theory for Two Circular Cylinders in Contact. . . . . 57—A-33

By Tsu-Tao Loo, Rensselaer Polytechnic Institute, Troy, N. Y. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

Contact problems are essentially nonlinear; nevertheless, the only approach to these problems has been through Hertz's approximate theory which is based upon linear theory of elasticity.

In general, this theory has been substantiated satisfactorily by tests and practical applications. It has been found, however, in some problems such as the loading of ball and roller bearings that a more refined theory is desirable.

In an earlier paper the author obtained a second approximation theory of three-dimensional elastic contact, in which the Taylor series used in describing the contacting surfaces was truncated at the fourth power rather than at the second-power terms as done by Hertz. Through this refinement, an additional term in the expression of the pressure distribution was found, and was shown to be appreciable as the eccentricity of the contact ellipse increases. However, Hertz's approximation in considering both contacting bodies as elastic half-spaces was still retained; i.e., the Boussinesq solution of a force on the half-space was used for the displacements of the points in the contact region.

In the present paper, the effect of curvature on the two-dimensional plane Hertz theory is discussed. The problem is the line contact of two infinitely long circular cylinders of dissimilar materials and radii. The solution is achieved by using the displacement field of an infinitely long circular cylinder under nondiametrical, equal, and opposite concentrated forces. The usual attack on the two-dimensional contact problems is through the two-dimensional analog of the Boussinesq problem. This suffers the same objection as in the three-dimensional problem; that is, approximating cylinders by half-spaces, thus neglecting the effect of curvature.

A second defect is that, unlike the three-dimensional problem, the normal approach is unobtainable. In the three-dimensional Boussinesq problem the displacements vanish at infinity and hence the normal approach can be computed.

However, in the two-dimensional Boussinesq problem the displacements do not tend to zero at infinity, and therefore while the results of this displacement field may be used in the neighborhood of contact they cannot be used to compute the normal approach of two distant points. Both these objections are eliminated in this paper. The effect of curvature is found to depend on the dimensionless parameters, P/E_1R_1 and P/E_2R_2, where P is the normal load per unit longitudinal length, R_1, R_2 are the radii of cylinders, and E_1, E_2 are their moduli of elasticity. If these parameters are much smaller than unity, then the effect is negligible. An expression for relative normal approach also is obtained, a result which heretofore has not been possible.

An Experimental Study of Initial and Subsequent Yield Surfaces in Plasticity. . . . . 57—A-37

By P. M. Naghdi, Mem. ASME, F. Essenburg, Assoc. Mem. ASME, and W. Koff, University of Michigan, Ann Arbor, Mich. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

Experimental results for twenty-five tubular specimens of a 24S-T-4 aluminum alloy, subjected to combined torsion-tension-reversed torsion, are reported in a study of the initial and two subsequent yield surfaces covering the first and the fourth quadrant of the axial stress-shear stress plane. Results are also given for two additional specimens subjected to tension followed by torsion, in order to compare the values of the initial shear modulus at the initiation of twist with the elastic shear modulus.

Spherical Symmetry in the Theory of Elasticity. . . . . 57—A-119

By F. Goded, General Eléctrica Espanola, Madrid, Spain. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

A study of the common characteristics of both plane symmetry and axial symmetry in the theory of elasticity is presented in Part 1 of this paper—the form of the stress tensor and the existence of further analogous symmetries. In Part 2, the subject deals with the possibility of the existence of further analogous symmetries which are found to be possible only in some specific cases. In particular, spherical symmetry is treated. The method of obtaining the stress function of this new symmetry and the equation which this function must satisfy also are discussed, together with the stresses expressed by means of this stress function. The paper ends with a brief review of a general solution of the stress function and an example of the application of this stress function to a given problem.

Axial-Temperature-Gradient Bending Stresses in Tubes . . . 57—A-13

By F. G. Hammitt, Mem. ASME, University of Michigan, Ann Arbor, Mich. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

A study is conducted of the bending stresses induced in a thin-walled tube adjacent to a joint between the tube and a heavier section by an axial temperature gradient imposed across the assembly.

A solution is shown using basic relations taken from the existing literature for a tube of uniform wall thickness attached at either end to a flange of infinite stiffness. Both long and short tubes are considered. The possibility of substantial reductions of stress through the use of a tapered wall thickness is discussed. Approximate methods are developed for the calculation of stress and wall thickness under conditions in which the wall thickness is varied in each instance to give (*a*) constant radius of curvature (or arbitrary radii of curvature), (*b*) constant stress, and (*c*) arbitrary stress distribution.

Further Deflection Analysis for a Plate Strip Subjected to Normal Pressure and Heating . . . . 57—A-14

By M. L. Williams, California Institute of Technology, Pasadena, Calif. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics*; available to Oct. 1, 1958).

In an earlier paper an analysis was carried out to determine the stresses and deflection in an infinite strip plate undergoing large deflections when the plate was subjected to a combined normal loading and uniform temperature rise through the thickness, both of which were permitted to vary across the plate width.

This paper extends the analysis and design charts to the case where the temperature distribution through the thickness of the plate may have any desired distribution. If the usual plate assumptions regarding plane sections remaining plane are valid, then the arbitrary temperature distribution can be represented completely by the average temperature and the first moment of the temperature about the plate middle surface, as far as the engineering stresses and deflections are concerned. The convenient nondimensional design charts cover equilibrium positions in the buckling as well as nonbuckling range, and show maximum stress and central deflection as a function of pressure, average temperature, and temperature moment for cases of both clamped and simply supported edges.

Nonaxial Bending of Ring Plates of Varying Thickness . . . . 57—A-92

By H. D. Conway, Cornell University, Ithaca, N. Y. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

A solution is given to the problem of the bending of circular ring plates of varying thickness which are subjected at their outer and inner edges to any system of forces and moments. The thickness is assumed to be proportional to any power of the radius, this having the effect of making the solution tractable. Numerical results are given for a plate, clamped at its inner, free at its outer, edge and subjected to a normal concentrated load on its outer edge. The constant-thickness version of this problem was first solved by Reissner.

Redundant Trusses of Elastic-Strain-Hardening Material . . . . . 57—A-28

By Hans Ziegler, Eidg. Technische Hochschule, Zurich, Switzerland. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

Ideal trusses are subject to the following assumptions: (*a*) Their elements are straight bars connected by smooth pins, the centers of which (the joints of the truss) lie on the center lines of the bars they connect. (*b*) The weights of the bars are so small compared with the other loads that they may be neglected. (*c*) The remainder of the external forces (loads and reactions) are acting at the joints.

These conditions assure that the bars are stressed in simple tension or compression.

If an ideal truss is statically determinate, the forces transmitted by the individual bars are entirely determined by the equilibrium of the joints and the bars, provided the deformations are so small that the geometry of the truss is not noticeably altered during the process of loading. Under this condition, the forces can be obtained, for instance, by means of a Maxwell diagram. They are independent of the rheological behavior of the materials employed, and likewise independent of the way the final state of loading has been reached. The design of the individual bars is, therefore, a straightforward process.

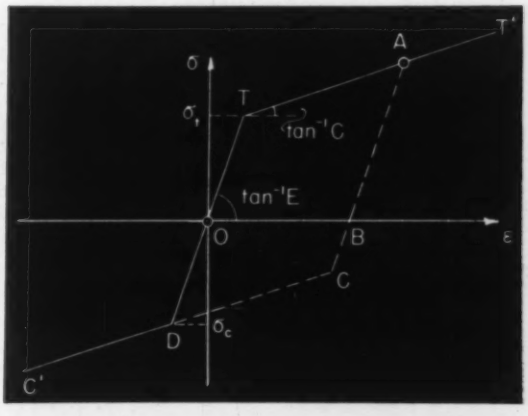
In a redundant truss, the situation is more complicated. Here, the distribution of the internal forces also depends on the deformations and thus on the dimensions of the elements as well as on their rheological response. Hence the stress analysis must be based on a tentative design of the members. Moreover, the final distribution under a given system of loads usually depends on the way in which these loads have been applied. A precise knowledge of this final distribution is obtained only by a careful study of the behavior of the truss during the various steps of the loading process.

In the case of a purely elastic truss, the necessity last mentioned does not yet arise. Here, the principle of Castigliano supplies the missing equations as soon as the dimensions of the members are given, and the internal forces are uniquely determined by the final loads.

The more complicated case of a truss consisting of elastic perfectly plastic bars has been discussed recently by W. Prager. His treatment is based on the fundamental idea of conceiving the state of stress in the truss as resulting from the superposition of more elementary states: A state of the first type for each parameter characterizing the system of loads, and a state of the second type for every degree of redundancy.

This elegant way of splitting up the state of stress is not only useful in the case of an elastic ideally plastic truss. In this paper, a generalization for elastic-strain-hardening trusses with given limit loads for each member (fracture loads, buckling loads) is presented.

The approach likewise is based on the assumption that the deformations are sufficiently small to maintain the original geometry of the truss. The treatment is essentially limited to the case of a simply redundant truss with a single load parameter



Stress-strain diagram assumed to be of the elastic - strain - hardening type when considering an arbitrary bar of the truss. ϵ denotes the strain and σ the stress. (57—A-28)

Bending of an Elastically Restrained Circular Plate Under Normal Loading Over a Sector.....57—A-8

By W. A. Bassali, University of Alexandria, Alexandria, Egypt, and R. H. Dawoud, Cairo University, Cairo, Egypt. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

The complex variable method is used to find the deflection, bending and twisting moments, and shearing forces at any point of a thin circular plate normally loaded over a sector and supported at its edge under a general boundary condition including the usual clamped and simply supported boundaries. In this way separate treatments for these two cases are avoided and a single treatment is available.

Some Basic Properties of Shoe Brakes.....57—A-6

By G. A. G. Fazekas, Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958, available to Oct. 1, 1958).

In a previous paper, the author has shown how performance of a fixed anchor shoe is affected by its geometry. The purpose of this paper is to show quite generally, for any kind of brake-shoe construction, how geometry affects performance, and how performance may be optimized. The treatment in the previous paper is extended to brake shoes that have two degrees of freedom of movement.

The Calculation of Optimum Concentrated Damping for Continuous Systems.....57—A-93

By R. Plunkett, Mem. ASME, General Electric Company, Schenectady, N. Y. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

A method is presented for calculating the optimum concentrated damping for the vibration of continuous systems. It is applied to (*a*) a string damped near one end, (*b*) a cantilever beam driven at the center and damped at the free end, (*c*) a uniform blade with dovetail damping, and (*d*) the damped dynamic absorber. Aside from the specific results which are shown in the examples, there are some general conclusions. The vibration velocity and vibratory force are not necessarily in phase at maximum amplitude for optimum damping. The decay rate at optimum damping is not necessarily related to amplification at resonance, that is

$$\delta = \pi Q$$

On the Transverse Vibrations of Rectangular Orthotropic Plates.....57—A-85

By N. J. Huffington, Jr., Assoc. Mem. ASME, Virginia Polytechnic Institute, Blacksburg, Va., and W. H. Hoppmann, II, The Johns Hopkins University, Baltimore, Md. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

Frequency equations and modal eigenfunctions have been determined for the flexural vibrations of rectangular plates of orthotropic material, for those cases which may be treated by the method of M. Lévy. In addition, for a broader class of boundary-value problems, an orthogonality criterion for the eigenfunctions has been established, and relations for the kinetic and potential energies derived. The value of these energy functions in dealing with forced vibrations is demonstrated.

General Instability of Ring-Stiffened Cylindrical Shells Subject to External Hydrostatic Pressure—A Comparison of Theory and Experiment.....57—A-73

By G. D. Galletly, Assoc. Mem. ASME, Shell Oil Development Company, Emeryville, Calif.; R. C. Slankard, Department of the Air Force, Washington, D. C.; and E. Wenk, Jr., Southwest Research Institute, San Antonio, Texas. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

In the strength design of ring-stiffened cylinders under external pressure, consideration must be given to all possible modes of yielding and instability failures. One such mode is that of general instability, in which both the stiffeners and shell plating undergo extensive deformation from end to end with serious loss in load-carrying capacity. Resistance to such failure requires provision of rings of adequate size and spacing, and, if properly chosen, the material may be loaded up to its yield point, which is probably an optimum condition for minimum weight.

Tests are described of a number of machined-stiffened cylinders subjected to external hydrostatic pressure, and the observed general instability strengths compared with predictions from theories of Kendrick and Nash. Agreement with Kendrick was found rather good. Results also are presented from electrical strain gages which show in detail the growth of embryonic lobes and nonlinear characteristics of deformation at the threshold of buckling. Weakening effects of imperfect circularity are discussed.

On the Dynamical Behavior of Rotating Shafts Driven by Universal (Hooke) Couplings.....57—A-1

By R. M. Rosenberg, University of Toledo, Toledo, Ohio. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

The system considered here is a massless, uniform elastic shaft carrying at its mid-point a disk (having mass) and supported at the ends by universal (Hooke) joints. The purpose of this investigation is to examine the effect of Hooke-joint angularity (as obtained by design, or from faulty alignment) on the bending stability of the rotating shaft. It is found that separate investigations are required for shafts not transmitting axial torques and for those required to transmit torques. Each gives rise to instabilities which are absent when the Hooke joint is straight. In the absence of axial torques, the shaft develops unsuspected mild critical speeds at odd integer submultiples of the "familiar" critical speed found with a straight Hooke joint. When the shaft is required to transmit moderate axial torques, the joint angularity produces true instabilities near all integer submultiples of the familiar critical speed. Surprisingly, these instabilities vanish for sufficiently large axial torques.

The Bursting Pressure of Cylindrical and Spherical Vessels...57—A-15

By N. L. Svensson, Imperial College of Science and Technology, London, England. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

The rational design of vessels subjected to internal pressure requires the study of two modes of failure. The first possibility of failure occurs when the deformation becomes excessive and there is a possibility of permanent deformation. The second type of failure occurs at a higher pressure and takes the form of bursting of the vessel. It is the purpose of this paper to derive an expression for the bursting pressure of cylindrical and spherical vessels manufactured from work-hardening materials.

The relationship between pressure and change of dimensions for cylindrical and spherical vessels subjected to internal pressure is considered for a material having a stress-strain curve of the form $\sigma = \sigma_0 \epsilon^n$. The equations obtained are analyzed further to obtain expressions for the bursting pressure for these vessels. From these results simplified expressions are obtained for the calculation of the bursting pressure for any vessel. Comparison with one set of experimental results shows excellent agreement.

Ring Damping of Free Surface Oscillations in a Circular Tank.... .....57—A-31

By J. W. Miles, Ramo-Wooldridge Corporation, Los Angeles, Calif. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

A rough analysis of the effect of an annular ring on the sloshing oscillations of liquid in a cylindrical tank is carried out. The damping per cycle (logarithmic decrement) for moderate amplitudes is predicted as proportional to the square root of the amplitude and the three-halves power of the ring area. The corresponding force on the ring also is calculated.

Velocity and Acceleration Analysis of Plane and Space Mechanisms by Means of Independent-Position Equations.....57—A-2

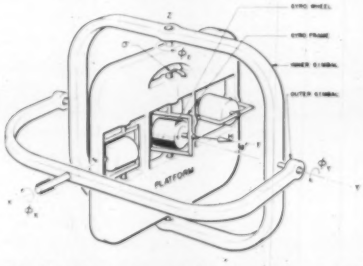
By F. H. Raven, Cornell University, Ithaca, N. Y. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

A generalized analytical method for the determination of velocities and accelerations in mechanisms having motion in either two or three dimensions is presented in this paper. In this method of analysis, one first obtains independent-position equations for a particular point or for a particular link. The first derivative with respect to time of these position equations yields equations for obtaining the velocity of the point or the angular velocity of the link of interest; and the second derivative with respect to time furnishes new equations from which the desired accelerations may be found. Position vectors are expressed as complex numbers in exponential form because of the ease with which they may be differentiated, and also because numerical results are readily obtainable from the real and imaginary parts.

Stress Distributions Around Hydrostatically Loaded Circular Holes in the Neighborhood of Corners..... .....57—A-4

By A. J. Durelli, Assoc. Mem. ASME, and A. S. Kobayashi, Assoc. Mem. ASME, Armour Research Foundation, Chicago, Ill. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

The stress distributions around hydrostatically loaded circular holes in the neighborhood of corners was determined by using photoelasticity and brittle coatings. Photoelasticity (by means of a diffused-light polariscope) was used to determine the maximum shear lines (isochromatics), and brittle coatings were used to determine the directions of the principal stresses (isostatics). Tests were conducted for six plates with different ratios of hole radius to hole distance to the exterior boundary of plate (R/L). The results of these tests are presented in the form of curves. These curves show the distribution of the maximum shear stress along the diagonal of the plate, the maximum principal stress along the edges of the plate and of the hole, and the maximum shear stress along a perpendicular line to the exterior boundary drawn from the center of the hole. All these values are given as a function of R/L. Curves also are presented which compare the stresses on the diagonal of the plate at the boundary of the hole with the stresses computed using Lamé's equation for a thick-walled cylinder. Comparisons also are made with the results obtained by Jeffrey for a semi-infinite plate with a circular hole subjected to a hydrostatic pressure. All results are given in dimensionless form with the applied pressure as reference. The results published in this paper are new, but the techniques used have been described previously in papers by researchers from the Armour Research Foundation.



Model of unrestrained, single-degree-of freedom gyroscope. (57—A-72)

Kinematic Drift of Single-Axis Gyroscopes.....57—A-72

By R. H. Cannon, Jr., Massachusetts Institute of Technology, Cambridge, Mass. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Otc 1. 1958).

A gyroscope can incur steady drift by kinematically rectifying angular vibrations of the platform on which it is mounted. The phenomenon, for an unrestrained single-degree-of-freedom gyro, results from oscillatory precession of the gyro momentum vector from its nominal spatial orientation, so that it senses platform motions about axes other than the one it is controlling. The magnitude of the drift can be accurately predicted and the vibration climate of the platform restricted accordingly. Quantitative experimental verification is presented.

Creep Deflections and Stresses of Beam-Columns.....57—A-3

By T. H. Lin, University of California, Los Angeles, Calif. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

The recent increase in the use of structures at elevated temperatures, as in the case of high-speed aircraft, has made it necessary to consider the creep effect in a number of structures. The growing importance of the creep deflection in columns has been recognized widely.

A method of calculating the creep deflections and stresses of a beam-column is shown. The differential equation of equilibrium in terms of creep strain is solved by the method of integrating factors with Green's function. For restrained and built-in ends, the end moments are found from the end conditions. An illustrative example is given for a beam-column of an ideal H-section with built-in ends and subjected to uniform lateral load. The deflection-time curve and flange stresses at different instants are shown.

A Blade-Vibration-Damping Device—Its Testing and a Preliminary Theory of Its Operation..... .....57—A-10

By R. A. Di Taranto, Assoc. Mem. ASME, Westinghouse Electric Corporation, Camden, N. J 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

Presented herein is a report on a wire-damping device which has shown considerable damping ability when placed in a hollow rotor blade. A series of tests is reported which have all shown the damping ability of this device at nonrotating and rotating conditions. Two theories are postulated and expressions derived to explain the mechanism of damping by the wires for nonrotating-type damping and rotating-type damping. The postulated mechanism for damping in the nonrotating rotor blade considers that the wires absorb energy by rubbing around one another as a result of the motion imparted by the vibratory motion of the blade. The postulated mechanism for damping in the rotating rotor blade considers that a component of centrifugal force holds the wires against the side of the blade, and the vibratory bending motion of the blade causes relative motion between the blade, wall and the adjacent wires to absorb energy. Criteria are set forth for determining which mechanism is operative. Good correlation was obtained between test and theory.

Stress-Strain Relations for a Simple Model of a Granular Medium..... .....57—A-90

By H. Deresiewicz, Assoc. Mem. ASME, Columbia University, New York, N. Y. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

A granular assemblage is represented by a model consisting of like spheres in contact arranged in a simple cubic lattice. Based on consideration of local contact forces and concomitant deformations, incremental stress-strain relations are derived and subsequently integrated, for certain types of loading, to yield total stress-strain relations. The integration is carried out for both a loading and an unloading process. A criterion of failure for the model is set up and the theory applied to a regimen of loading which gives rise to a plane state of stress.

Contact Stresses Under Combined Pressure and Twist.....57—A-95

By M. Hetényi, Mem. ASME, and P. H. McDonald, Jr., Northwestern University, Evanston, Ill. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

An analytical solution is presented for the case when an elastic sphere is pressed against an elastic half-space and twisted until complete slip occurs. Formulas are derived for the stress and displacement components, their evaluation is illustrated by numerical examples and comparisons are made with the results of photoelastic tests. These tests also furnished an experimental verification of the assumption that the tangential-surface traction is proportional at every point to the normal pressure within the sliding-contact area, the proportionality constant being the coefficient of friction.

On the Sloshing of Liquid in a Flexible Tank.....57—A-12

By J. W. Miles, The Ramo-Wooldridge Corporation, Los Angeles, Calif. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

The kinetic and potential energies of an incompressible fluid having a free surface in a cylindrical tank subjected to translation, rotation, and simple bending are derived in the forms

$$\frac{1}{2}\sum_i\sum_j m_{ij}\dot{q}_i\dot{q}_j \text{ and } \frac{1}{2}\sum_i\sum_j k_{ij}q_iq_j$$

where the $q_i(t)$ are generalized co-ordinates. The results are illustrated by a calculation of the frequency equation for coupled bending and free-surface motions. It is found that, if the mass of the empty tank is small compared with that of the liquid and the depth of the liquid is equal to the tank diameter, the presence of the free surface increases the bending frequency (relative to that calculated with a plane cap that coincides with the liquid surface and is normal to the axis of the cylinder) by about 5 per cent for cantilever bending oscillations and 27 per cent for free-free bending oscillations.

Effect of Finite Rotations on Gyroscopic Sensing Devices..57—A-30

By L. E. Goodman, Mem. ASME, and A. R. Robinson, Assoc. Mem. ASME, University of Minnesota, Minneapolis, Minn. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

The modern gyroscope is a highly accurate means of sensing angular velocities. Its application in inertial guidance systems, where it is used to determine space orientations, imposes on the designer the necessity of insuring stability and sensitivity. In particular, translational motions such as linear vibration ought not induce any tendency for the axis of rotation (spin axis) of the instrument to change its spatial orientation. It was therefore a matter of interest when, during an investigation of the sources of vibration drift of single-degree-of-freedom integrating gyros, it was noted that gyros mounted on the table of a commercial linear vibrator often exhibited abnormally high drift rates at frequencies close to the resonances of the table supports. Even after a theory had been developed which correctly predicted the effect of the additional degrees of freedom arising from flexibility of the gyro parts, the abnormal drift rates at the frequencies just mentioned were not accounted for.

In an effort to bring these exceptional cases within the scope of a dynamical theory, the table motions were measured carefully. It was found that at the particular frequencies in question the table motion consisted of a slight wobble superposed on and coperiodic with the expected linear motion. The noncommutativity of finite rotations suggested that a three-dimensional rotational motion which returned a single-degree-of-freedom gyro to its original orientation might produce a residual signal; that is, an apparent drift. This, it developed, is the correct explanation. The anomalous drift is explained completely and its magnitude determined by means of a kinematical theorem developed in the next section. This effect is basically geometric and would be present even in a theoretically perfect instrument; it is, however, in practice, modified by the details of the way in which the motion of the outer case is transmitted to the gimbal. Since the effect of "conical

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ASME TRANSACTIONS

The March, 1958, issue of the *Transactions of the ASME*, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers), contains the following:

Technical Papers

Analysis of Plane and Space Mechanisms, by F. H. Raven. (57—A-2)

Some Basic Properties of Shoe Brakes, by G. A. G. Fazekas. (57—A-6)

Tensor Flexibility Analysis of Closed-Loop Piping Systems, by J. W. Soule. (57—F-3)

Accurate Solutions of Partial Differential Equations, by H. G. Landau. (57—F-1)

A Blade-Vibration-Damping Device, by R. A. Di Taranto. (57—A-10)

Bending Frequency of a Rotating Cantilever Beam, by M. J. Schilhansl. (57—F-6)

Timoshenko Beams Under Dynamic Loads, by B. A. Boley and Chi-Chang Chao. (57—A-17)

Circular Plate Loaded Over a Sector, by W. A. Bassali and R. H. Dawoud. (57—A-8)

Dynamics of Rotating Shafts in Hooke Couplings, by R. M. Rosenberg. (57—A-1)

Bounds of Eigenvalues of a Clamped Plate, by R. K. Kaul and S. G. Tewari. (57—A-32)

Natural Frequencies of Nonuniform Beams, by R. A. Di Taranto. (57—F-5)

Pressure for Indenting Material on Rough Foundation, by W. Johnson and D. M. Woo. (57—A-24)

Bending of Pretwisted Thin-Walled Beams, by L. Maunder. (57—A-84)

Creep Deflections and Stresses of Beam-Columns, by T. H. Lin. (57—A-3)

Carrying Capacity of Strain-Hardening Shell, by P. G. Hodge, Jr., and S. V. Nardo. (57—A-5)

Thermal Stresses in Transversely Isotropic Elastic Solids, by B. Sharma. (57—A-22)

Bursting Pressure of Cylindrical and Spherical Vessels, by N. L. Svensson. (57—A-15)

Axially Symmetric Motions of Thick Shells, by I. Mirsky and G. Herrmann. (57—A-19)

Reflection of an Acoustic Step Wave, by Richard Skalak and M. B. Friedman. (57—A-7)

motion," as this wobble has been termed, cannot be designed out of the instrument, it necessarily must be considered in the design of inertial guidance systems as well as in gyro testing. Some of these considerations are discussed in the last section of this paper.

Carrying Capacity of an Elastic-Plastic Cylindrical Shell With Linear Strain-Hardening.....57—A-5

By P. G. Hodge, Jr., Mem. ASME, S. V. Nardo, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1957 ASME Annual Meeting paper (in type; in the *Journal of Applied Mechanics*, March, 1958; available to Oct. 1, 1958).

When a rigid, perfectly plastic circular cylindrical shell is subjected to a combination of end load and radial pressure, the carrying capacity of the shell is its collapse load and may be easily determined. If there is no end load, or if the end load is tensile, the collapse load so determined also will be a reasonable approximation to the carrying capacity of an actual shell which exhibits elastic strains and strain-hardening. However, if the end load is compressive, this no longer will be the case. The compressive end load will act on the elastic radial displacement to produce a greatly increased axial bending moment, the so-called beam-column effect. If reasonable answers are to be obtained, the elastic strains must be taken into account in the analysis.

The approximate capacity of a thin-walled closed circular cylindrical shell, simply supported at each end and subjected to a uniform hydrostatic pressure, is determined in this paper. Elastic and plastic strains are considered, and the latter are assumed to follow a linear law of isotropic hardening. The principle of minimum potential energy is used to determine an approximate solution for the stress resultants, displacements, and maximum load. In an example, it is found that the carrying capacity is considerably lower than that predicted by either rigid-plastic theory or elasticity theory.

Torsion of Cylindrical and Prismatic Bars in the Presence of Steady Creep.....57—A-27

By S. A. Patel, B. Venkatraman, and P. G. Hodge, Jr., Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1957 ASME Annual Meeting paper (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1958).

In a structure subject to creep, in general the strain is a function of time, stress, temperature, total deformation, and aftereffects. The experimental laws governing this relationship are far too complicated to lend themselves to easy analytical treatment of the creep problem in engineering structures. Moreover, a physical description of the phenomena which cause creep is many sided. From a practical standpoint, it is too complex to be of much use at present. Finally, the creep properties of engineering materials are extremely sensitive to small changes in the temperature and the stresses, and creep experiments show considerable scatter.

This paper is concerned with the steady creep behavior of cylindrical and prismatic bars in which the deformations are caused by pure torsion. The creep problem is first reduced to one in nonlinear elasticity by means of the elastic analog. The elastic analysis is then carried out by means of the principles of minimum energies. These principles yield upper and lower bounds on the angle of twist. Closed-form solutions also are presented for some cross sections.

Axial - Temperature - Gradient Bending Stresses in Tubes, by F. G. Hammitt. (57—A-13)

Torsion and Flexure of Slender Solid Sections, by W. J. Carter. (57—F-4)

Effect of Curvature on the Hertz Theory for Cylinders, by Tsu-Tao Loo. (57—A-33)

Displacement Discontinuity in Elastic Half-Space, by Leif Rongved and J. T. Frasier. (57—A-23)

Stress Distribution Around a Circular Inclusion, by E. M. Saleme. (57—A-18)

Spherical Symmetry in Theory of Elasticity, by F. Goded. (57—A-119)

Design Data and Methods

Oil-Film Properties for Unbalance Vibration Calculations, by A. C. Hagg and G. O. Sankey

Brief Notes

Deflections of Plates on Viscoelastic Foundation, by E. Reissner

A Theorem in Plane Kinematics, by J. S. Beggs

Transient Conduction in a Semi-Infinite Solid, by Kwang-Tzu Yang

Discussion

On previously published papers by F. S. Weinig; Philip Levine; H. Poritsky and R. A. Powell; S. R. Bodner; W. C. Hagel and J. W. Clark; E. A. Ripperger and H. N. Abramson; Hirsh Cohen and Robert Gilbert; W. A. Hijab; J. C. Georgian; J. M. Robertson and J. W. Holl; S. H. Crandall and W. G. Strang

Book Reviews

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COMMENTS ON PAPERS

Vacuum Metallurgy

Comment by A. Tilles[1]

THE author of this paper[2] has presented most interestingly a large amount of important information. Certain marginal questions come to mind.

Questions

1 For some of the larger units discussed, as the one shown in Fig. 14, what degree of vacuum, specifically, is used, for how long must it be applied, and what size and type of vacuum pump container are utilized?

2 Similarly for the "package" shown in Fig. 12, some additional detail as to the scheme of assembly, the method of carrying through the vacuum, the degree and duration of vacuum required, and the size and type of the vacuum pump and container, if any, would be of great interest.

3 The bend samples shown in Fig. 13 have what thickness of cladding? Are the bends indeed crack-free and impervious to liquids, as would appear in the photograph?

4 Does vacuum cladding show promise of being superior to plating, either cost or performancewise, for production of silver or platinum covering on copper, bronze, or aluminum for electrical contacts?

5 What degree and duration of vacuum might be desirable for vacuum pouring or heat-treating of large steel ingots to eliminate hydrogen and atmospheric gases?

Considerable attention has been given, in this country during the past year, to the practice of vacuum pouring of large, i.e., over 100-ton, ingots of alloy steel in order to minimize hydrogen content and other contamination. Could you give some comment about how this is done? Does this practice give promise of being effective and reasonably economic?

[1] Robert E. Thomas & Associates, San Francisco, Calif.

[2] "Vacuum Metallurgy Gives Industry a Glimpse Into the Future," by R. C. Bertossa, MECHANICAL ENGINEERING, vol. 79, November, 1957, pp. 1039–1041. Condensed from ASME Paper No. 57—SA-95.

Author's Closure

Dr. Tilles poses some detailed questions on vacuum techniques. Some of the data obtained are as yet considered confidential, but I shall attempt to answer these questions as completely as possible with data available for publication.

Answers

1 The degree of vacuum required depends on the types of materials being melted, brazed, or otherwise heat-treated, and the purpose of the vacuum treatment.

In the case of high-temperature metal claddings such as titanium, tantalum, columbium (niobium), molybdenum, and the like, a higher degree of vacuum must be maintained than would be required for brazing stainlesses, high-nickel alloys, and other metals which do not exhibit the sensitivity to atmospheric gases shown by the high-temperature metals.

On larger stainless and high-nickel-alloy clad-plate assemblies for fabrication into vessels of the size shown in Fig. 14, it can be readily seen that the degree of vacuum will fluctuate widely at intervals during the heating cycle, due to outgassing of the metal surfaces comprising the assembly. This outgassing can decrease the vacuum to a pressure as high as 3000 microns or more at peak outgassing in assemblies such as those shown in Fig. 12.

The vacuum is maintained continuously on the assemblies during heating and while the brazing alloy layer is in the molten condition; however, it may be continued or discontinued during the cooling and subsequent heat-treating cycles, again depending upon the types of materials involved.

Vacuum-pumping equipment of various sizes is used in the work, depending on size of work, and again, on the types of materials being brazed. For assemblies of high-temperature, gas-sensitive metals, backing pumps of the two-stage variety have been used, plus oil-diffusion pumps. Another arrangement is to use a single backing pump plus a booster pump plus an oil-diffusion pump. The pump sizes can be calculated after the assembly size and approximate evacuation efficiency of the system have been established.

By the word "container," I assume that Dr. Tilles refers to a vacuum-tight outer metal cover or envelope around the assembly. An outer container is sometimes used; however, it is the usual procedure (and this was the procedure followed in producing the stainless-carbon-steel clad plates illustrated in Fig. 12) to utilize the carbon-steel base plates of the outer two clad-plate assemblies as the container. These outer plates are vacuum-sealed by welding and are partially protected from the oxidizing furnace atmospheres during the brazing cycles by thin layers of materials which will not affect significantly the heat-transfer characteristics of the assembly.

2 Question 2 is answered as completely as allowed under Answer 1, with the exception of the method of carrying the vacuum. This consists of one or more tubes welded to the assembly in areas found by experiment to give greatest efficiency of evacuation. These tubes are connected to the pumping system on the outside of the furnace. Suitable connections and apparatus are used to allow mobility of the work in charging and removing it from the furnace while under high vacuum.

3 The bend specimens of vacuum-pressure clad plate shown in Fig. 13 have 0.109-in. and 0.187-in. thicknesses of clad layers, respectively. The bend specimen on the left consists of Inconel clad on ASTM A-285, Grade "C" Fbx. carbon steel. The one on the right is composed of Type 316L stainless-steel clad on ASTM A-212, Grade "B" Fbx. carbon steel.

The bends are crack-free and impervious to penetration by liquids as a result of the continuous, ductile bond resulting from flux-free, high-vacuum bonding techniques.

4 Vacuum cladding is considered superior to plating performancewise in that a completely nonporous coating is obtained. Coatings of 0.01-in. and thinner would be more suitably applied by plating. Above 0.01-in. thickness, the minimum practical cladding thickness would be determined by the types of metal combinations desired, the metallurgical bonding characteristics of the components, and the ratio of thickness of clad layer to thickness of base metal. It is conceivable that some very thin clad sheets suitable for certain types of electrical contacts would be economical, using assembly techniques by which a considerable number of individual clad plates were produced in one "pack," or assembly group.

5 In vacuum heat-treating of large steel ingots, a vacuum on the order of less than five microns would be desirable, preferably in the neighborhood of one micron, to obtain efficient degassing. The temperature required depends, of course, on the types of metals treated (see Table 1). In pouring liquid metals, again, a vacuum of less than five microns is desirable. This degree of vacuum can, in some instances, be obtained with the use of a backing pump only.

Depending on the properties required, it is quite possible that lesser degrees of vacuum can be used effectively. Oxide films on steels have been observed to break down and be removed from the plate surfaces at vacuum levels of around and above 200 microns.

6 I do not feel qualified to comment on the techniques and problems involved in vacuum pouring 100-ton ingots of alloy steel; however, designing suitable equipment for vacuum treatment of the molten steel during pouring operations appears to be feasible, and I see no reason why it could not be accomplished reasonably economically, considering the improvement obtained in the properties and performance of the steel by vacuum heat-treatment.

R. C. Bertossa.[3]

[3] Senior metallurgist, department of metallurgy, Stanford Research Institute, Menlo Park, Calif.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

Automatic Control

Random Process in Automatic Control

By J. Halcombe Laning, Jr., and Richard H. Battin. McGraw-Hill Book Co., Inc., New York, N. Y., 1956. Cloth 6 × 9 in., figs., tables, bibliography, index, ix and 434 pp. $10.

Reviewed by Rufus Oldenburger[1]

THE importance of the statistical approach to automatic control has been emphasized by Prof. Norbert Wiener, who made fundamental contributions to this subject. In designing a control system one should make the system fit the disturbances to be actually experienced rather than step changes, sinusoidal or other inputs that may not be encountered in practice. Because of enormous mathematical difficulties in applying statistical techniques the approach of Wiener has had virtually no industrial application. Wiener's theory is limited to linear systems subject to stationary random disturbances. Another important factor is that a system designed to give good response to step changes will also give good response, although not optimum, to random variations.

The book under review provides the control expert with basic background in the statistical approach to control problems, which is not restricted to stationary processes.

The book begins with the basic concepts of probability theory essential to an understanding of statistical control problems. Point sets, random variables, characteristic functions, binomial, Poisson, and normal distributions are among the topics discussed. This is followed by statistical descriptions of random processes through probability distribution, autocorrelation and correlation functions, and power spectral densities. For purposes of exposition, characteristic and correlation functions and spectral densities are derived for the shot effect and Gaussian random processes. Correlation functions are given for the outputs of simple nonlinear devices such as a rectifier. The design of an automatic radar tracking system is treated, where the problem is to follow a signal in the presence of interference.

In treating time-invariant linear systems subject to disturbances which are stationary random processes, the authors follow the work of Wiener. The authors consider the effects of eliminating each of the assumptions that the device under design be linear, that the rms error be minimized to give the optimum design, that both signal and noise are stationary random processes, and that the device be permitted to operate on the entire past history of the signal and noise data. Although the treatment given for devices, where one or more of these assumptions are not satisfied, leaves much to be desired, the authors give an excellent introduction to the mathematical techniques that may be employed in these areas. The treatment is scanty because relatively little is known about the subject.

Without electronic computers it would be hopeless to try to apply much of the statistical theory presented in the book. The authors, therefore, wisely include

[1] Professor of Mechanical Engineering, Purdue University, Lafayette, Ind. Mem. ASME.

appropriate analog computer techniques.

The concept of "performance index" is introduced in the book. This is a quantitative measure of the extent to which a given system is satisfactory. This is a difficult concept to define because the designer's concept of what is optimum for one system will not be the same for another.

The point of view is that of analysis rather than synthesis. The mathematics necessary for an understanding of the subject is well presented. The authors have succeeded in producing a lucid, concise volume which should do much to bridge the gap between statistical control theory and its application in industry.

Cams

Cams: Design, Dynamics, and Accuracy

By Harold A. Rothbart. John Wiley & Sons, Inc., New York, N. Y., 1956. Cloth, 6 × 9 in., index, appendixes, references, figs., tables, examples, solutions, notations, xiv and 350 pp., $9.50.

Reviewed by Ferdinand Freudenstein[2]

This is the first serious English work on the subject of cams since the publication of Furman's book of the same title in the year 1921. In those days it appeared to some that "the whole subject . . . was so thoroughly covered . . . that . . . there was but little . . . to look forward to in the way of production of extended original work." While this quotation from Furman's preface is admittedly out of context, it does point out the tremendous development which has occurred since then.

The gravity cam, the uniform-rise cam, and other well-known cam profiles were satisfactory only at low speeds. Today, in many applications, it is the high-speed dynamic response of the cam and follower system which governs the design and use of the cam. Different profiles, such as the cycloidal, less likely to cause shock and vibration, are being extensively used. Cam-follower system characteristics, which were hardly thought of 40 years ago, require careful consideration today. Among these are characteristics involving mass, inertia, elasticity, damping, surface films, surface finish, machining accuracy, tolerances, and load characteristics.

The author has ably presented the modern state of the art of cam design in a book of moderate size and has placed emphasis on dynamic response and high-speed characteristics. The book fills a definite void in the literature. In addition to the more elementary and standard treatment of cams presented in the first five chapters, there are six additional ones, the titles of which suggest the scope of the treatment: Advanced Curves; Polydyne Cams; The Dynamics of High-Speed Cam Systems; Force Analysis; Surface Materials, Stresses, and Accuracy; Special Cams and Applications. The presentation is lucid, the diagrams are clear, the mathematical treatment is elementary, and numerical examples are included. Of particular value is the extensive set of references given at the end of each chapter. Our knowledge of cam behavior is still limited, and mathematical analysis and experimental investigation of the many factors affecting high-speed cam performance are in the initial stages or still nonexistent. The machine designer will, therefore, not find an answer to all his cam questions in this book. He will find, however, a summary of best practice to date, an introduction to modern thinking on cams, and numerous references to further, more detailed literature.

The level of presentation is sufficiently elementary so that most of the book can be understood by those with a high-school mathematical background or its equivalent.

Whether in cams, gears, or linkages—those old and basic machine elements—our rapidly developing technology requires a far greater understanding of the kinematic and dynamic design of these elements than was necessary years ago. Concerning our knowledge of these, even today, it might be said that "we have barely scratched the surface at present." In virtue of its integrated treatment of cams the book under review represents a contribution toward a more scientific approach to the subject. It is recommended reading to anyone concerned with their design.

[2] Associate professor, department of mechanical engineering, Columbia University, New York, N. Y. Assoc. Mem. ASME.

BOOKS RECEIVED IN LIBRARY

ASTM Specifications for Steel Piping Materials.
Published 1957 by the American Society for Testing Materials, Philadelphia, Pa. 445 p., 6 × 9 in., paper. $4.50. These specifications cover pipes used to convey liquids, vapors, and gases at normal and elevated temperatures, still tubes for refining service, heat exchanger and condenser tubes, and boiler and superheater tubes. In addition, specifications are also included for castings, forgings, and bolts and nuts used in pipes and related installations. There are 27 new specifications included since the previous Sept. 1955 edition.

ASTM Standards on Cement
Published 1957 by the American Society for Testing Materials, Philadelphia, Pa., 264 p., 6 × 9 in., paper. $3. A compilation of all the ASTM standards pertaining to cement, substantially revised since publication of the previous edition in 1955. Seven of the 34 standards have been revised and one test method has been discontinued. In addition to specifications and tests, the publication contains appendixes giving information on balances and weights, a manual of cement testing, selected references on Portland cement, and other data.

Air Conditioning
By W. R. Woolrich and W. R. Woolrich, Jr. 1957, The Ronald Press Company, New York, N. Y. 384 p., 6 1/8 × 9 3/8 in., bound. $7.50. Part 1 of this text is devoted to the general thermodynamics of air conditioning and problems of system-load determination and design. Part 2 covers the elements of heating systems from a discussion of fuels and combustion to a coverage of heat-transfer elements such as boilers, radiators, and convectors. Part 3 provides an exposition of the types of refrigeration, including cooling by iced air and evaporation. Part 4 deals with five areas: piping design, air distribution, automatic control and instrumentation, sound control, and air-contaminant control. The authors have devoted more space than usual to psychometric processes, radiant cooling, and available means of refrigeration.

Atomkraft; der Bau von Atomkraft-werken und Seine Probleme
By Friedrich Münzinger. Second Edition, 1957. Springer-Verlag, Berlin, Germany. 224 p., 6 1/4 × 9 3/8, in., bound. DM 29.40. An introduction to the problems involved in the construction of nuclear power plants. Intended for engineers, industrialists, and power economists the three main sections deal with: theoretical fundamentals of nuclear energy; reactor technology, including heat engines; and economic aspects of nuclear plants as power producers.

Diesel Engine Catalog
Vol. 22, 1957–1958. Edited by Rex W. Wadman. Published 1957 by Diesel Progress, Los Angeles, Calif. 396 p., 10 3/8 × 13 3/8 in., paper. $10. This annual guide provides details on the construction of the engines and engine parts of the major manufacturers in the diesel industry. Information on superchargers,

turbocharger, transmission and equipment manufacture is included, as well as a classified buyers' guide.

Digital Calculating Machines
By G. A. Montgomerie. 1956, D. Van Nostrand Company, Inc., Princeton, N. J. 262 p., $5^3/_4 \times 8^7/_8$ in., bound. $6.75. A manual for engineers and scientists who want to make effective use of these machines in their work. Four groups of machines are covered: desk-type calculators, punched-card systems, special-purpose machines for extensive mathematical operations, and universal sequence controlled machines. Numerous illustrations and examples of operations of the machine are included.

Digital Computer Programming
By D. D. McCracken. 1957, John Wiley & Sons, Inc., New York, N. Y. 253 p., $5^7/_8 \times 9^1/_4$ in., bound. $7.75. A general introduction to the entire field intended for engineers and others who want to know how to prepare detailed instructions for the stored program computer. Emphasizing basic principles, the book discusses coding, binary and octal number systems, input-output methods, magnetic tape programming, automatic coding, and other aspects of programming. The discussion is illustrated by detailed examples written for a mythical computer representing major trends in present computer building.

Engineering Economics and Ethics for Professional Engineers' License
By John D. Constance. Published 1957 by John D. Constance, Cliffside Park, N. J. Various pagings, $8^1/_2 \times 11$ in., paper. $2.50. Brief notes and worked-out examples from past State examinations for professional engineer's license. The subject matter includes bond issues, bond valuation, debt amortization, property valuation, depreciation, cost analysis, contacts, specifications, business law, and professional ethics and practice.

The Foundations of Metallography
By Georg Masing. Monograph and Report Series No. 21. 1956, The Institute of Metals, London, England. 166 p., $5^3/_8 \times 8^5/_8$ in., bound. $3.50. A concise introduction for students of metallurgy, also useful to those working in the field. It covers a wide variety of topics including the atomic structure of metals and alloys and the structure of alloys in systems with and without solid solutions or compounds. Other topics covered are the process of crystallization, changes in the solid state (iron-carbon, copper-zinc, and zinc-aluminum alloys), heat-treatment, plastic deformation, internal stress, recrystallization, corrosion, and oxidation. The book is a translation from the fourth German edition published in 1955.

Gmelin's Handbuch der anorganischen Chemie
Eighth Edition. Verlag Chemie, Weinheim, Germany. American Representative: D. R. Stein, Pelham Manor, N. Y. Two new volumes are now available of this monumental compilation of information and survey of literature sources: No. 28. CALCIUM. Part A, Section 2, 1957. 488 p., $6^7/_8 \times 10^1/_8$ in., paper. $55.68. The major part of this volume is devoted to the geochemistry of calcium, the industrially important deposits of fluorspar, calcium phosphate, gypsum, etc., and a descriptive summary of calcium minerals. Although element calalcium is not of particular economic importance, some 90 pages are devoted to its physical properties and its electrochemical and chemical behavior. The final section treats the alloys of calcium with antimony, bismuth, lithium, sodium, potassium, and beryllium. No. 32. ZINC. Supplementary Volume, 1956. 1025 p., $6^7/_8 \times 10^1/_8$ in., bound. $138. The geochemistry of zinc and its economic geography, covering all important deposits, are first dealt with. The next section covers technical preparation, including ore dressing, metallurgical operations, electrolytic production, and refining. Physical properties, electrochemical behavior, and chemical behavior of zinc are next taken up, followed by a considerable section on the major alloys of zinc. The surface treatment of zinc and zinc alloy products is considered, and the characteristics of a wide range of zinc compounds are examined, especially with oxygen, chlorine, and sulfur.

Heating, Ventilating, Air-Conditioning Guide, vol. 35, 1957.
Published 1957 by the American Society of Heating and Air-Conditioning Engineers, Inc., New York, N. Y. 520 p., $6 \times 9^1/_4$ in., bound. $12. Topics newly or more extensively treated in this year's volume include U-value tables for building construction; sound control; control of industrial environment; design of ceiling and floor-heating panels; and forced warm air systems. The volume, an authoritative guide to current practice, is made up of seven main sections dealing with fundamentals, human reactions, heating and cooling loads, combustion and consumption of fuels, systems and equipment, special systems, and instruments and codes. A manufacturers' catalog data section is included.

High Speed Diesel Engines
By Arthur W. Judge, Fifth Edition, 1957. D. Van Nostrand Company, Inc., Princeton, N. J. 578 p., $5^3/_8 \times 8^3/_4$ in. bound. $12. An elementary textbook for engineers, designers, draftsmen, and students, this fifth edition has tried to keep up with the rapid development of the high-speed compression-ignition engine. Subjects covered include the combustion process, engine performance, fuel-injection systems, and fuels. New chapters are devoted to starting, supercharging, small vehicle engines, air-cooled engines, and special purpose engines.

A History of Mechanics
By René Dugas. 1957, Central Book Company, Inc., New York, N. Y. 671 p., 6×9 in., bound. $15. A translation from the French edition published in 1950. Part 1 deals with the important men, schools of thought, fields of activities, and developments from the Greeks and Arabs to the 17th century. The formulation of classical mechanics during the 17th century is discussed in part 2, with parts 3 and 4 covering developments during the 18th and 19th centuries. The last part of the book discusses 20th century concepts: the relativity theory; quantum mechanics; wave mechanics; and statistical mechanics. The author has exercised sufficient selectivity to provide a logical and coherent treatment within a reasonable scope.

Semiconductor Surface Physics
Edited by R. H. Kingston and others. 1957, University of Pennsylvania Press, Philadelphia, Pa. 413 p., $5^3/_4 \times 8^3/_4$ in., bound. $8. This volume contains the proceedings of the Conference on the Physics of Semiconductor Surfaces held at Philadelphia in 1955. It is comprised of 23 papers grouped in four sections paralleling the sessions of the conference: clean surfaces, real surfaces, adsorption and catalysis, and oxidation. The individual papers present the latest interpretations of surface states, surface-conductance, and related phenomena, as well as reports on experimental techniques used to study the properties of semiconductor materials.

Seminar on Wind Tunnel Techniques and Aerodynamics
Published 1955 by the Royal Institute of Technology, Stockholm, Sweden. Various pagings, $8^1/_8 \times 11^1/_2$ in., paper. Price not given. The papers of this seminar, held in Stockholm, May, 1954, cover many aspects of the subject including the design and use of sonic and supersonic wind tunnels, strain-gage balances, electronic apparatus, flow around various types of wings, drag, and air intakes. Swedish wind tunnels are described, and a final paper discusses the financial background and organization of aeronautical research and development in Sweden.

Solar Radiation in Air Conditioning
By Ivor S. Groundwater. 1957, Crosby Lockwood & Son, Ltd., London, England. 125 p., $5^1/_2 \times 8^5/_8$ in., bound. 25 s. A handbook for engineers planning air conditioning for buildings in the tropics. Information is given on the special difficulties involved in making calculations because of sun load in these regions. The discrepancies among the various methods are discussed. The methods are related to specifications of the plant and particulars of the building, and there is material to assist in making calculations direct from meteorological data should this be necessary. There are sections showing calculations and actual performance data.

Symposium on Solder
(Special Technical Publication No. 189.) Published 1957 by The American Society for Testing Materials, Philadelphia, Pa. 190 p., 6×9 in., paper. $3. The 16 papers and their discussions here published were presented at various sessions of the Annual Meeting of the ASTM in 1956. Sample topics are ultrasonic soldering of aluminum, dip soldering printed circuits, industrial survey of paste solder alloys, corrosive and noncorrosive fluxes, and rosin fluxes. A group of papers deal with joint-strength characteristics.

Symposium on Tension Testing of Non-Metallic Materials
(Special Technical Publication No. 194.) Published 1957 by The American Society for Testing Materials, Philadelphia, Pa. 81 p., 6×9 in., paper. $2. This group of five papers and discussions presented at the 1956 Annual Meeting of the ASTM deals with testing of adhesives, paper, plastics, rubber, and wood, wood-base materials, and sandwich constructions.

Systems Engineering
By Harry H. Goode and Robert E. Machol. 1957, McGraw-Hill Book Company, Inc., New York, N. Y. 551 p., $6 \times 9^1/_4$ in., bound. $10.

LIBRARY SERVICES

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

In organizing the various aspects involved in the systems approach to the problem of designing equipment, this book logically combines the new set of tools, new classification of parts, and the team of workers necessary to this approach. At the same time it provides for the engineer, as a member of the system-design team, a background for his job and describes system-design methods. A selective bibliography and illustrative problems with solutions are included.

Thermodynamics
By Virgil M. Faires. 1957, The Macmillan Company, New York, N. Y. 543 p., 6 × 9½ in., bound. $7.50. This edition of a standard college text has been extensively rewritten, reoriented, renamed, and, to some extent, reorganized because of the increase in knowledge surrounding the concept of entropy.

Die Transformatoren
By Milan Vidmar. Third Edition, 1956. Birkhauser Verlag, Basel, Switzerland. 630 p., 6½ × 9⅝ in., bound. Swiss Frs. 68.00. A comprehensive treatise on the theoretical and practical aspects of large power transformers. Major headings are as follows: general characteristics of transformers; design of the transformer; the three-phase transformer; heat transfer during operation; the iron core, no-load operation, and switching surges; the windings; boundary problems in transformer design; practical examples of transformers. Completely revised, after 30 years, on the basis of the author's extensive experience in the field.

Vapour Phase Chromatography
Edited by D. H. Desty and C. L. A. Harbourn. 1957, Academic Press Inc., Publishers, New York, N.Y. 436 p., 6⅛ × 10 in., bound. $12. Thirty-six papers dealing with such subjects as the thermodynamics of gas-liquid chromatography; detection of vapors in flowing gas streams; chromatography at high temperatures; analysis and control of refinery gas streams; and gas chromatographic separation of hydrogen isotopes. The papers comprise the proceedings of a symposium sponsored by the Hydrocarbon Research Group of the Institute of Petroleum in London, in 1956.

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

THE Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting Jan. 10, 1958, and approved by the Board on March 11, 1958.)

Case No. 1122-7

(Reopened) (Special Ruling)

In the February, 1958, issue of MECHANICAL ENGINEERING, *Reply*, Par. (1)(b), revise the yield strength for Type 316L from 30,000 to 25,000 psi.

Case No. 1246

(Special Ruling)

(Allowable Stress Values for Austenitic Steel Forgings)

Inquiry: Considerable difficulty is being experienced in consistently meeting the 75,000 psi room temperature tensile strength specified for austenitic steel forgings under Specification SA-182 when heavy sections are involved. Until such time as appropriate changes can be made in the specification, may austenitic steel forgings that fall short of the minimum specified room temperature tensile strength at 75,000 psi be used at the higher temperatures and if so, what stress values shall be used in design?

Reply: It is the opinion of the Committee that austenitic steel forgings that comply in all respects to the requirements of Specification SA-182, with the exception that the room temperature tensile strength falls below that specified but not less than 70,000 psi, may be used at temperatures of 1000 F and above by employing the same stress values in design as given in Tables P-7 and UHA-23 for the corresponding grades having the specified tensile strength.

Case No. 1247

(Special Ruling)

(Aluminum Alloy 5083)

Inquiry: May sheet and plate of aluminum alloy 5083,[1] having the following chemical composition and conforming to the applicable requirements of Specification SB-178, be used in the construction of fusion welded unfired pressure vessels under Section VIII of the ASME Code?

	PER CENT
Magnesium	4.0–4.9
Chromium	0.05–0.25
Copper	0.10 max
Manganese	0.30–1.0
Zinc	0.25 max
Titanium	0.15 max
Iron	0.40 max
Silicon	0.40 max
Other, each	0.05 max
Other, total	0.15 max
Aluminum	Remainder

Reply: It is the opinion of the Committee that the aluminum alloy 5083 described in the inquiry may be used for the construction of unfired pressure vessels provided the applicable rules of design, fabrication, and inspection of the Unfired Pressure Vessel Code (Section VIII) are followed, with the following additional provisions:

1. *Specifications* Sheet and plate shall conform to the requirements of Specification SB-178. The chemical composition shall be as listed in the inquiry and mechanical properties shall be as in Par. 2.
2. *Mechanical Properties* The mechanical properties of the material are not less than in Table 1.
3. *Welding* The welding qualification requirements of Part B, Section IX, apply except that longitudinal bend tests may be substituted for transverse bend tests. The 5083 alloy is classed

[1] ASTM tentative designation GM41A.

CASE NO. 1247—TABLE 1

Condition	Thickness	Tensile strength, psi	Yield strength, psi (0.2 per cent offset)	Elongation in 2 in., per cent
Annealed	to 0.750	40,000	18,000	16
Annealed	0.750–2.000	38,000	16,000	16
H113	to 2.000	44,000	31,000	12

in group P-24 of Table QN-11.1. The tensile strength of the reduced section tensile specimens shall not be less than the minimum specified tensile strength of the annealed temper. The filler metal may be of the following composition[2]:

	PER CENT
Magnesium	4.3–5.2
Chromium	0.05–0.25
Copper	0.10 max
Manganese	0.50–1.0
Zinc	0.25 max
Titanium	0.15 max
Iron	0.40 max
Silicon	0.40 max
Beryllium	0.0005 max
Other, each	0.05 max
Other, total	0.15 max
Aluminum	Remainder

4. *Allowable Stresses* The following maximum allowable stress values are used in applying the design rules where reference is made to Table UNF-23:

Condition	Thickness	Metal Temp Not Exceeding Deg F 100	150
Annealed	to 0.750	10,000	10,000
Annealed	0.750–2.000	9,500	9,500
H113	to 2.000	11,000	11,000

5. *Impact Requirements* Since this alloy does not undergo a marked drop in impact resistance at low temperatures, no additional requirements are specified for temperatures down to −325 F. (See Par. UNF-65.)

6. *Thermal Stress-Relief* Thermal stress-relieving is not mandatory.

7. *Appurtenances and Attachments* In addition to the material described herein, any of the aluminum alloy materials for which allowable stress values for welded construction are given in Table UNF-23 may be used for appurtenances and other attachments. These parts and their connections shall be designed in accordance with the lower of the stress values in Par. 4 above and the applicable values in Table UNF-23. The welding process for these connections shall be qualified in accordance with the applicable rules of Section IX, except that the strength of the reduced-section tensile specimen shall be not less than the lower of the specified tensile strength of the two materials in the annealed temper.

Cautionary Note: On prolonged exposure to temperatures between 200 and 350 F, this alloy becomes susceptible to failure by stress corrosion. Vessels made of this alloy may be exposed to elevated temperatures under exposure conditions comparable to occasional steam cleaning, but should not be used in service at temperatures exceeding 150 F.

[2] ASTM tentative designation GM51B, Aluminum Association tentative designation 5183.

Case No. 1248
(Special Ruling)
(Use of Aluminum Alloy GM51A (5456))

Inquiry: May aluminum alloy GM-51A, which has the following chemical composition, be used in the construction of fusion welded unfired pressure vessels under Section VIII of the ASME Code?

	PER CENT
Magnesium	4.7 to 5.5
Chromium	0.05 to 0.20
Copper	0.20 max
Manganese	0.7 to 1.0
Zinc	0.25 max
Titanium	0.20 max
Beryllium	0.0005 max
Iron plus Silicon	0.40 max
Other, each	0.05 max
Other, total	0.15 max
Aluminum	Remainder

Reply: It is the opinion of the Committee that unfired pressure vessels using aluminum alloy GM51A, described in the Inquiry, will meet the intent of the ASME Code provided the following special provisions are followed in addition to the applicable rules of Section VIII for the design, fabrication and inspection:

1. Sheet and plate shall meet the applicable requirements of Specification SB-178.

2. Rods, bars, and shapes shall meet the applicable requirements of Specification SB-273.

3. Pipe and tube shall meet the applicable requirements of Specification SB-274.

4. The mechanical properties determined in accordance with the applicable specification shall be not less than those given in Table 1.

5. Fabrication shall be by fusion welding. The filler metal may be of the same composition as the parent metal except the copper shall be 0.10 per cent max and the titanium shall be 0.05 to 0.20 per cent.

6. The qualification of the welding procedure, welders and welding operators shall conform to the requirements of Section IX except:

(*a*) The radius of the mandrel used in the guided-bend test may be $1\frac{1}{4}$ in. instead of $\frac{3}{4}$ in., and

(*b*) The tensile strength of the reduced-section tensile specimens shall be not less than 42,000 psi.

Separate qualifications shall be made for this material.

7. The following maximum allowable stress values shall be used in applying the design formulas where reference is made to Table UNF-23:

Condition	Metal Temp Not Exceeding Deg F 100	150
Annealed, H112, H311	10500	10400
H321	11000	10900

In the design of fusion-welded joints, the allowable stress values for the annealed condition shall be used.

8. For continuous operation, the temperature shall in no case be less than −325 nor greater than 150 F.

9. Since this alloy does not undergo a marked drop in impact resistance at low temperatures, no additional requirements are specified for temperatures down to −325 F.

10. Bolting materials shall conform to an aluminum alloy listed in Table UNF-23 or one of the grades of austenitic steel of Specification SA-193. The bolting materials shall not be welded. The allowable stress values in Tables UNF-23 and UHA-23 shall apply.

11. In addition to the material described herein, any of the aluminum alloys for which allowable stress values for welded construction are given in Table UNF-23 may be used for appurtenances and other attachments. These parts and their connections shall be designed in accordance with the lower of the stress values in Par. 7 above and the applicable value in Table UNF-23. The welding process for the connections shall be qualified in accordance with the applicable rules of Section IX except, that the strength of the reduced section tensile specimen shall be not less than the lower of the specified tensile strength of the two materials in the annealed temper.

12. Cylindrical and spherical shells for external pressure and formed heads with the pressure on the convex side shall be designed by the rules of Section VIII and Fig. UNF-28.20.

CASE NO. 1248—TABLE 1

Product	Condition	Thickness, in.	Tensile Strength, psi	Yield Str. 0.2 per cent offset, psi	Elongation in 2 in., per cent
Any	Annealed	—	42000	19000	16
Sheet and Plate	H321	0.250–1.250	46000	33000	12
		1.250–2.000	44000	31000	12
Rods, Bars,	H112	—	42000	19000	12
Shapes, Pipe, Tube	H311	—	42000	25000	12

Cautionary Note: To avoid a decrease in the resistance to stress-corrosion by severe cold forming of alloys of this type, it is recommended that either the vessel parts be maintained at a temperature between 425 and 525 F during forming operations, or the formed parts be stress-relieved at a temperature between 425 and 475 F for a period of 4 hours or annealed. The rate of cooling from the stress-relieving temperature is unimportant, but where annealing (temperature range 650 to 800 F) is employed, the parts shall not be quenched or air-blast cooled.

For critical applications, it is recommended that the user consult the material producer.

(*Note:* Fig. UNF-28.20, referred to in Case 1248, will be included in the Case Interpretation sheets.)

Case No. 1249

(Special Ruling)

(Use of Types 309 and 310 Austenitic Steels)

Inquiry: Is it permissible to construct vessels to operate under external pressure in accordance with the requirements in Section VIII of the Code using Type 309 or Type 310 austenitic steel?

Reply: It is the opinion of the Committee that vessels to operate under external pressure may be constructed of Type 309 or Type 310 austenitic steel under the rules in Section VIII provided:

(1) The rules for design and construction of vessels constructed of high-alloy steel are complied with.

(2) The required thickness of shells and heads, and the required moment of inertia for stiffening rings, shall be determined from the chart in Fig. UHA-28.2.

(a) The use of Fig. UHA-28.2 for Type 309 austenitic steel shall be limited to 1100 F maximum.

Case No. 1250

(Special Ruling)

(Use of Types 405 and 410 Stainless Steel)

Inquiry: Is it permissible to construct vessels to operate under external pressure in accordance with the requirements in Section VIII of the Code using Type 405 or Type 410 stainless steel?

Reply: It is the opinion of the Committee that vessels to operate under external pressure may be constructed of Type 405 or Type 410 stainless steel under the rules in Section VIII provided:

(1) The rules for design and construction of vessels constructed of high-alloy steel are complied with.

(2) The required thickness of shells and heads, and the required moment of inertia for stiffening rings, shall be determined from the chart in Fig. UCS-28.2.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As NEED arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Power Boilers, 1956

PAR. P-1 Revise as follows.

Delete present subpars. P-1(a) and (b) and substitute the following:

P-1 Prefabricated or preformed pressure parts for boilers which are subject to allowable working stresses due to internal or external pressure in the boiler and which are furnished by other than the shop of the manufacturer responsible for the completed boiler shall conform to all applicable requirements of the Code as the completed boiler, including inspection in the shop of the parts manufacturer and the furnishing of partial data reports as provided for in Par. P-332(d)(3) and (4) except as permitted in (a), (b) and (c).

(a) *Cast, Forged, Rolled, or Die-Formed Standard Pressure Parts*

(1) Pressure parts such as pipe fittings, valves, flanges, nozzles, welding necks, welding caps, manhole frames and covers and casings of pumps which are part of a boiler circulation system, that are wholly formed by casting, forging, rolling, or die forming shall not require inspection, mill test reports, or partial data reports; however, they shall be made of materials permitted under Section II of the Code or in an accepted standard (such as ASA) covering the particular type of pressure part. Such parts shall be marked with the name or trademark of the manufacturer and such other markings as are required by the several standards. Such markings shall be considered as the manufacturer's certification that the product complies with the material specifications and standards indicated and is suitable for service at the rating indicated. The intent of this paragraph will have been met, if, in lieu of the detailed marking on the part itself, the parts described herein have been marked in any permanent or temporary manner that will serve to identify the part with the manufacturer's written listing of the particular items and such listings are available for examination by the Inspector.

(2) Parts of small size falling within this category, for which it is difficult or impossible to obtain identified material, or which may be stocked and for which mill test reports or certificates cannot be economically obtained and are not customarily furnished, and which do not appreciably affect the safety of the boiler, may be used for relatively unimportant parts or parts stressed to not more than fifty per cent of the stress value permitted by this section of the Code, provided they are suitable for the purpose intended and meet the approval of the Inspector. The manufacturer of the completed boiler shall satisfy himself that the part is suitable for the design conditions specified for the completed boiler.

(b) *Cast, Forged, Rolled, or Die-Formed, Nonstandard Pressure Parts* Pressure parts such as shells, heads, removable and access opening cover plates that are wholly formed by casting, forging, rolling, or die-forming, may be supplied basically as materials. All such parts shall be made of materials permitted under Section II of the Code and the manufacturer of the part shall furnish mill test reports or other acceptable evidence to that effect. Such parts shall be marked with the name or trademark of the manufacturer and with such other markings as will serve to identify the particular parts with accompanying material identification. The manufacturer of the completed boiler shall satisfy himself that the part is suitable for the design conditions specified for the completed boiler.

(c) *Welded Standard Pressure Parts for Use Other Than the Shell of a Boiler*[1] Pressure parts such as pipe fittings, nozzles, welding necks, welding caps, valves, flanges and manhole frames that are fabricated by one of the welding processes recognized by the Code shall not require inspection, mill test reports, or partial data reports, provided:

[1] Fusion welded pipe for use as the shell of a vessel shall be subject to the same requirements as a shell fabricated from plate, including inspection at the point of manufacture and partial data reports.

(1) All such parts are made of materials permitted under Section II of the Code or in an accepted standard (such as ASA).

(2) If arc or gas welded, the welding complies with Section IX of the Code.[2]

Such parts shall be marked with the name or trademark of the manufacturer and with such other markings as will serve to identify the materials of which the parts are made. Such markings shall be considered as the manufacturer's certification that the product complies with (1). A statement by the parts manufacturer that all welding complies with Code requirements shall be accepted as evidence that the product complies with (2).

(3) If radiography or heat treatment is required, it may be performed either in the plant of the parts manufacturer or in the plant of the manufacturer of the completed vessel.

If the radiographing is done in the plant of the parts manufacturer, the completed radiographs, properly identified with the respective parts, shall be available to the authorized Inspector. If the radiographs are examined in the plant of the parts manufacturer, parts data sheets shall be executed and forwarded to the vessel manufacturer.

(4) If heat treatment is performed at the plant of the parts manufacturer, a statement by the manufacturer that such treatment was performed shall be accepted as evidence of compliance with applicable Code paragraphs. The manufacturer of the completed vessel shall satisfy himself that the part is suitable for the design conditions specified for the completed vessel.

PAR. P-1(d) Reletter present Subpar. (c) to read (d).

TABLE P-7 Add a new Note (13) to read:

(13) These stress values apply only when the carbon is 0.04 per cent or higher.

Also insert this numbered reference in the table under the heading "Notes" to show that it applies to all grades of austenitic steels in the 300 series.

PAR. P-23(f) Revise to read:

(f) *Variation in Pressure and Temperature* Piping systems shall be considered safe for operation if the maximum sustained pressure and temperature on any part do not exceed the design pressure and temperature under this Code for all component parts of the system. It is recognized that variations in pressure and temperature inevitably occur and therefore the piping system shall be considered safe for occasional operation for short periods at higher than the design pressure and temperature.

Either pressure or temperature, or both, may exceed the design values if the stress in the pipe wall calculated by the formulas using the maximum expected pressure during the variation does not exceed the S-value allowable for the maximum expected temperature during the variation by more than the following allowances for the periods of duration indicated:

(1) Up to 15 per cent increase above the S-value during 10 per cent of the operating period;

(2) Up to 20 per cent of the S-value during 1 per cent of the operating period.

[2] For requirements for welded water columns see last subparagraph of Par. P-229(a).

Material Specifications, 1956

Delete only the following grades from the specifications listed:

Nonferrous Materials

SB-98 Alloy A and D, Hard and Extra Hard, Alloy B, Hard

SB-127 Cold-Rolled Sheet and Strip Hard; Roofing Quality, Satin-Finished Tempered Sheet

SB-149 Leaded Ni-Brass Castings

SB-152 Cold-Rolled Tempers

SB-162 Nickel-Hard, Cold-Rolled Sheet and Strip

SB-164 Class A, Forged, High Tensile, Ni-Cu Rods and Bars

SB-166 Cold Drawn Rounds, Hexagons, Flats

SB-168 Cold Rolled Sheet and Strip, Hard

SB-169 Alloys A and C

SB-171 70–30 Cu-Ni over 2.5, Alloys D and E

Low-Pressure Heating Boilers, 1956

FIG. H-1 Renumber as Fig. H-1(a).

FIG. H-1(b) Add new figure—"Chart for Determining Wall Thickness of Plain Horizontal Cylindrical Furnaces or Flues when Constructed of Carbon Steel (Specified Yield Strength, 24,000 to 30,000)." (*Note:* This figure is available from the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th Street, New York 18, N. Y.)

PAR. H-13(a)(3) Revise where mention of Fig. H-1 occurs in four places to change this reference from ". . . . Fig. H-1 . . . ." to read ". . . . H-1(a) or Fig. H-1(b)."

Unfired Pressure Vessels, 1956

PAR. UG-33(b) Revise "t = minimum . . ." to read "t_h = minimum. . . ."

PAR. UG-33(d) Under "Step 1" revise "t" to read "t_h."

PAR. UW-50 Delete present paragraph and substitute the following:

UW-50 Inspection of Welds on Pneumatically Tested Vessels On welded pressure vessels that are to be pneumatically tested in accordance with Par. UG-100, all welds around openings and all attachment welds, having a throat thickness greater than $^1/_4$ in., shall be inspected for their entire length for the detection of possible cracks, by the magnetic particle method, or alternatively by a penetrating colored or fluorescent oil method.

PAR. UG-100 Revise title to read:
UG-100 Pneumatic Test[2] (See Par. UW-50)

PAR. P-23(5) Revise to read:

TABLE UCS-23 For Spec. SA-7, under the Notes column, add "(19.)"

Under the Notes, add a new Note (19) to read:

(19) These allowable stress values apply also to structural shapes.

TABLE UHA-23 Under the Notes, add a new Note (10) to read:

(10) These stress values apply only when the carbon is 0.04 per cent or higher.

Also insert this numbered reference in the table under the heading "Notes" to show that it applies to all grades of austenitic steels in the 300 series.

Welding Qualifications, 1956

PAR. Q-11 Revise Subpar. V-2, d-2 to read:

(a) For submerged arc welding a change in filler metal analysis from one A-Number in Table Q-11.3 to any other A-Number or to any analyses of weld deposit not listed in the table, except as stated in (b) and except as permitted in Notes 2 and 4 of Table Q-11.3.

Add new subparagraph (b) to read:

(b) In submerged arc welding, where the alloy content of the weld metal is largely dependent upon the composition of the flux used, any change in any part of the welding procedure which would result in the important alloying elements in the weld metal being outside of the specification range of chemistry given in the welding procedure specification. If there is evidence that production welds are not being made in accordance with the procedure specifications, the inspector may require that a check be made on the chemical composition of the weld metal. Such a check shall preferably be made on a production weld.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

New United Engineering Center—looking southwest from 48th Street to 47th Street, New York, N. Y.

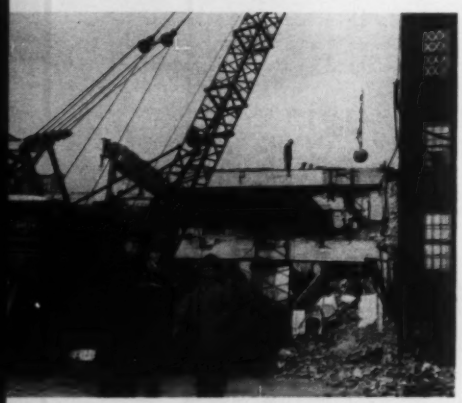
Demolition of structures on site completed for . . .

. . . New United Engineering Center

DEMOLITION of present structures on the site of the new United Engineering Center, United Nations Plaza from 47th to 48th streets, New York, N. Y., was completed in late March and actual ground breaking for new construction is expected later this year. The new Center is expected to be ready for occupancy in the fall of 1960.

Concurrently, leadership for the Greater New York City Commerce Campaign for the United Engineering Center Building Fund was announced by Walter E. Barrett, president of United Engineering Trustees, Inc.

The Honorable Robert F. Wagner, Mayor of the City of New York, will serve as Honorary Chairman.



W. H. Byrne, *left,* general chairman of the New York City Commerce Campaign, and W. J. Barrett, *center,* president of United Engineering Trustees, Inc., discuss demolition operations at new Center site with job foreman

William H. Byrne, Vice-President, Region II, and Fellow ASME, will serve as General Campaign chairman. Solicitation is planned among smaller employers of listed member engineers in the Greater New York City area and prospects selected from commercial and financial firms.

When completed, the new United Engineering Center will stand as enduring evidence of the unity and strength of the engineering profession.

The contemplated 20-story tower, an entirely functional and usable building, will bear witness to the ideals, stability, and prestige of engineers.

With about 250,000 sq ft of floor space, the Center will meet in full all present requirements of the Founder Societies and Associate Societies. (A combined total of 284,000 member engineers.) The design provides for ample expansion with the continuing growth of the engineering profession and even greater service essential for future generations.

Integrated Service

Designed with a single purpose in mind, the Center will provide facilities for efficient, effective, and economical service to member engineers throughout the country.

The Engineering Library, already recognized as containing the most outstanding collection of general engineering literature in the world, will become even more useful to the membership. A major portion of the Library's service to engineers is provided by mail. In the new Center, the Library, with additional space and equipment, can handle the many requests for data and research with greater speed and effectiveness.

Meeting and Conference Rooms. For members of the societies serving on committees or attending section meetings or study groups, there will be a sufficient number of rooms so designed as to make these sessions even more productive.

Publication Facilities will strengthen communication to the members of engineering knowledge through the publications of the various societies.

Displays and Exhibits will inform engineers and the general public of the vital accomplishments of the profession.

Centralized Service Areas and administrative offices will add to the effectiveness of the day-to-day work of the societies in serving their members. The co-ordination of such activities as duplicating, addressing, and mailing will mean greater efficiency and economy.

Member Gifts

However, to bring this project to full realization will depend to a large extent on the individual members of the various Societies. Total cost of the New Center is estimated at $10 million, allocated as follows. $2 million from United Engineering Trustees, Inc., $5 million from business and industry, and $3 million from individual members of the various societies.

Chairman of the ASME member gifts campaign is W. F. Ryan, past-president ASME; F. L. Bradley, vice-chairman.

As the campaign gains momentum, every member will have an opportunity

to contribute. (Gifts to UEC are tax-deductible.)

As Charles F. Kettering, Fellow ASME and Honorary Chairman of the Member Gifts Campaign, puts it:

"Every engineer has a responsibility to participate in attaining this great objective by making a personal contribution to the United Engineering Center Fund Campaign.

"The program is sound. It is timely. It merits your support."

PEOPLE

Honors and Awards. STUART SYMINGTON, United States Senator from the State of Missouri, has received the Wright Brothers Memorial Trophy. The award presented by the National Aeronautical Association cited his distinguished career of public service in the field of aviation.

J. C. HUNSAKER, Hon. Mem. ASME, professor-emeritus, M.I.T., and former NACA chairman, received the highest honor of the Royal Aeronautical Society, its Gold Medal. The formal presentation was made by 1957 RAeS President Sir George Edwards at Institute of the Aeronautical Sciences Honors Night Dinner. ARTHUR E. RAYMOND, 1954 ASME Spirit of St. Louis Award Winner; vice-president, engineering, Douglas Aircraft, and former IAS president, was awarded the Daniel Guggenheim Medal at the same event.

RALPH A. CLARK, Electro Metallurgical Company, Division of Union Carbide and Carbon Company, Cleveland, Ohio, has been named the 1958 recipient of Thomas W. Pangborn Gold Medal of the American Foundrymen's Society. HOWARD J. ROWE, Aluminum Company of America, Pittsburgh, Pa., will receive the society's William H. McFadden Gold Medal; and WILLIAM W. MALONEY, general manager and secretary-treasurer, AFS, the Joseph S. Seaman Gold Medal.

CARL F. KAYAN, Mem. ASME, professor of mechanical engineering, Columbia University, New York, N. Y., has been made a fellow of the American Society of Heating and Air-Conditioning Engineers. Others similarly honored were: ALBERT L. BAUM, the late ALFRED C. BUENSOD, Mem. ASME; EDWARD L. CROSBY, EDMUND P. HECKEL, FRANK B. ROWLEY, Mem. ASME; and GEORGE M. SIMONSON.

JOHN CHIPMAN, head, metallurgical department, M.I.T., received the American Society for Metals Gold Medal at the second World Metallurgical Congress. TOKUSHICI MISHIMA, professor-emeritus, University of Tokyo, received the Albert Sauveur Achievement Award. ROY C. MCKENNA, chairman of the board, Vanadium Alloys Steel Company, Latrobe, Pa., was awarded the Gold Medal for the Advancement of Research.

GEORGE LEWIS TUVE, Mem. ASME, professor of mechanical engineering and director of Bingham Laboratories, Case Institute of Technology, Cleveland, Ohio, received the F. Paul Anderson Medal from the American Society of Heating and Air-Conditioning Engineers at the ASHAE banquet, January 29.

DAVID G. SIMONS, Major, United States Air Force, received the 1958 science and engineering award of The Drexel Institute of Technology, at its Engineers' Day convocation, January 17. Major Simons, a physician, is chief of space biology at Holloman Air Development Center, Alamogordo, N. Mex.

EDMUND A. PRENTIS, president, Prentis, White and Spencer, Inc., engineering consulting firm, has been selected as the recipient of the 1958 Alexander Hamilton Medal. The award is made by the Association of the Alumni of Columbia College to a former student or a member of the faculty "for distinguished service in any field of human endeavor."

MAXWELL M. UPSON, Fellow ASME, chairman of the board, Raymond Concrete Pile Company, New York, N. Y., received the first annual alumni achievement award of the Cornell Alumni Association of New York City.

ROGER M. BLOUGH, chairman of the board of directors, United States Steel Corporation; JOHN R. DUNNING, Mem. ASME, dean of the school of engineering,

J. G. Jackson, past-president, Engineers' Club of Philadelphia, Pa., accepts a plaque commemorating the Fiftieth Anniversary of the founding of the American Institute of Chemical Engineers at the Club. G. E. Holbrook, *left*, president of the Institute, presents the plaque as Dr. Frederic Dennerth, a charter member, looks on. Philadelphia will be the focal point of the Institute's special Jubilee Convention during the week of June 22, 1958. Several outstanding events are being planned.

Columbia University; and DANIEL K. WRIGHT, Mem. ASME, formerly with General Electric Company, were the recipients of this year's Stevens Honor Award in recognition of notable achievement in their respective fields.

LINN HELANDER, Mem. ASME, received the first Award of Merit plaque from the Life Members Club of the American Society of Heating and Air Conditioning Engineers at a special ceremony in Kansas City, Kan. Mr. Helander headed the department of mechanical engineering at Kansas State College from 1935 until his retirement from administrative duties last summer.

Education. ERNST WEBER has been named the sixth president of the Polytechnic Institute of Brooklyn. He succeeds HARRY S. ROGERS, Mem. ASME, who died on June 6.

SIR RICHARD SOUTHWELL, 1941 ASME Worcester Reed Warner Medallist, will be a visiting professor of mechanical engineering at The Rice Institute, Houston, Texas, until June, 1958. Sir Richard will lead an Applied Mechanics Seminar and will give a series of lectures.

PETER CIOFFI has been appointed assistant professor in the department of physics and mathematics at Lowell Technological Institute, Lowell, Mass. EMERY I. VALKO, vice-president in charge of research and development, Onyx Oil and Chemical Company, Jersey City, N. J., has become associate professor in the Division of Chemistry.

Appointments. W. LAURENCE LEPAGE, aeronautical engineer and management consultant, has been elected president of The Franklin Institute. He succeeds S. WYMAN ROLPH who has been head of the scientific organization for six years.

THOMAS DAVIS FONTAINE has been appointed program director for fellowships, Division of Scientific Personnel and Education, the National Science Foundation. For the past two and one-half years, Dr. Fontaine has served as administrative assistant to SENATOR JOHN C. STENNIS of Mississippi.

THORNDIKE SAVILLE, dean-emeritus, College of Engineering, New York University, has been named to head a study on the development of the University of Florida's Science and Technology Center. The study will be financed by a grant of $75,000 from the Ford Foundation.

New Officers. E. R. NEEDLES, consulting engineer and former ASCE president, and O. B. J. FRASER, metallurgical engineer, International Nickel Company, were elected president and vice-president, respectively, of the Engineers Joint Council for 1958. E. LAWRENCE CHANDLER continues as treasurer, E. PAUL LANGE as secretary, and L. K. WHEELOCK as assistant secretary.

AUGUSTUS B. KINZEL, vice-president, Union Carbide Corporation, has been named president of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc. He will hold office for one year.

H. THOMAS HALLOWELL, JR., has been re-elected president of the American Standards Association for his third consecutive term. CYRIL AINSWORTH, technical director of the association, has been appointed deputy managing director and will continue to serve as assistant secretary. J. W. MCNAIR, assistant technical director, will succeed Mr. Ainsworth as technical director and will assume duties as assistant secretary of the organization. VICE ADMIRAL GEORGE F. HUSSEY, JR., USN (ret), was re-elected managing director.

KARL E. JOHNSON, Mem. ASME, vice-president and general manger, J. F. Pritchard and Company of California, Kansas City, Mo., was elected president of the Cooling Tower Institute for 1958.

JOHN B. DAY, head, material handling group, School of Industrial Engineering, Georgia Institute of Technology, has been elected chairman of the College-Industry Committee on Material Handling Education of the Material Handling Institute. He succeeds HAROLD T. AMRINE, Mem. ASME, professor, and head of the department of industrial engineering, Purdue University.

Civic Responsibility. ADRIANO C. OLIVETTI, Mem. ASME, president, Olivetti and Company, Ivrea (Torino), Italy, announced in Rome that his ten-year old Community movement would present candidates for the parliamentary elections next spring in most or all Italian constituencies. Mr. Olivetti's movement has in the past played a role in municipal and regional politics in Piedmont and northwest Italy. The movement is based on regional self-government and local co-operation between all economically and intellectually active groups.

U of Illinois to Conduct Seminar on New American Drawing Standard

THE Division of University Extension of the University of Illinois recently announced a seminar on the New American Drawing Standard to be conducted by the General Engineering Department of the University in co-operation with the American Standards Association, the Central Illinois Sections of ASME and SAE, and Illinois Society of Professional Engineers.

This meeting is the outgrowth of the success achieved at the American-British-Canadian Conference on Unification of

The School of Textiles at North Carolina State College, Raleigh, N. C., inaugurates William H. Harriss collection of modern fabrics. Present on the occasion are, *left to right*, B. A. Alford of Cluett, Peabody & Company, Inc.; C. H. Bostian, chancellor, North Carolina State College; W. H. Harriss, principal speaker, textile counselor, Sanforize Division, Cluett, Peabody; R. M. Dowling, Cluett, Peabody; M. E. Campbell, dean, N. C. State College School of Textiles; and B. L. Whittier, head, textiles development department, N. C. State College. The Harriss collection of modern fabrics was established by Cluett, Peabody & Company, Inc., to honor Mr. Harriss, who was graduated from the college in 1895. Between 200 and 300 samples of fabrics will be displayed in the collection each year. Plans call for displaying fabrics from all parts of the world. Mr. Dowling made the presentation which was followed by a luncheon at the Raleigh Country Club honoring Mr. Harriss.

Drafting Standards held October, 1957, in Toronto, Ont., Canada.

The two-day program takes the following pattern:

Tuesday, April 29

Registration	9:30 a.m.
Economy Through Standards, by *S. H. Watson,* RCA	11:00 a.m.
Luncheon	12:15 p.m.
Welcome by Dean W. L. Everitt, College of Engineering, U of Illinois	
Graphic Illustrations in Sales, Service, and Production, by *Frederick Jantz,* Oldsmobile Division, GM	1:30 p.m.
True Position Dimensioning, by *T. J. O'Connor,* Bell Tel Lab	3:00 p.m.
Social Hour and Banquet	6:30 p.m.
Shoot for the Moon, by *Frank Beach,* U of Illinois	

Wednesday, April 30

Tolerancing of Form, by *George Noble,* Dominion Engineering Company, Montreal, Canada	9:30 a.m.
Maximum Material Concept Applied to Tolerancing of Form and Position, by *P. G. Belitsos,* GE	11:00 a.m.
Luncheon	12:15 p.m.
Proposed Symbols for Tolerancing of Form and Position, by *Stuart Miller,* U. S. Dept. of Defense	1:30 p.m.

For information write: Mr. R. K. Newton, Supervisor of Engineering Extension, 725 S. Wright, Champaign, Ill.

Progress in Aviation Prods Greater Activity in Human Engineering

THE most recent issue (February, 1958) of the Bulletin of the Human Factors Society of America contains the minutes of its first national meeting and constitutional convention.

The dedicated purpose of the Society is described in the Constitution, saying: "It has been organized to increase and diffuse the knowledge of man-machine-environment factors in all its ramifications, pure and applied, to promote the mutual interests of investigators of man-machine-environment problems, of supporting sciences, of designers, manufacturers and users of products and apparatus of all kinds related to man, and to encourage co-operation among them.

"The Society cordially invites to membership all who are interested in the aims of the Human Factors Society, either in research, in instruction, in engineering design, or in the manufacture and the distribution of man-operated or utilized devices, and in the sciences dealing with man which support the human factors field."

There already has been established an intimate relationship between the Human Engineering Committee of the Aviation Division and the Human Factors Committee of the Management Division of The American Society of Mechanical Engineers, and the HFSA.

Several members of these committees, including such noted leaders in the field as Jesse Orlansky, Maurice Rappaport, Renato Contini, Donald Ross, and Allison Simons as well as T. A. Marshall, Jr., senior assistant secretary, ASME, all participated in the Constitutional Convention of the HFSA.

Anyone who is interested in receiving further information about the HFSA should contact Donald Hanifan, secretary, Human Factors Society of America, P.O. Box 24032, Los Angeles 24, Calif.

MEETINGS OF OTHER SOCIETIES

April 14–15

American Institute of Electrical Engineers, ninth rubber and plastics conference, Sheraton-Mayflower Hotel, Akron, Ohio.

April 17–18

Institute of Environmental Engineers, annual meeting, New Yorker Hotel, New York, N. Y.

April 20–23

American Institute of Chemical Engineers and Chemical Institute of Canada, Canada-U.S. chemical engineering conference, Sheraton-Mt. Royal Hotel, Montreal, Canada.

April 21–23

Metal Powder Association, annual meeting and powder metallurgy show, Sheraton Hotel, Philadelphia, Pa.

April 21–26

American Industrial Hygiene Association, annual meeting as part of 1958 National Industrial Health Conference, Claridge Hotel, Atlantic City, N. J.

April 22–24

American Society of Lubrication Engineers, annual meeting and exhibit, Hotel Cleveland, Cleveland, Ohio.

April 27–May 1

The Electrochemical Society, Inc., annual spring meeting, Hotel Statler, New York, N. Y.

May 1–8

American Society of Tool Engineers, annual meeting, Convention Center, Philadelphia, Pa.

May 4–7

Instrument Society of America, national instrumentation flight-test symposium, Park-Sheraton Hotel, New York, N. Y.

May 5–7

Air-Conditioning and Refrigeration Institute, annual meeting, The Homestead, Hot Springs, Va.

May 5–7

Purdue Industrial Waste Conference, Purdue Memorial Union Building, Lafayette, Ind.

May 6–8

Western Joint Computer Conference, Ambassador Hotel, Los Angeles, Calif.

May 7–17

1958 Mechanical Handling Exhibition and Materials Handling Convention, Earls Court London, England.

May 14–16

Society for Experimental Stress Analysis, Hotel Manger, Cleveland, Ohio.

May 19–24

Second World Congress on the Prevention of Occupational Accidents, Brussels, Belgium.

May 31–June 8

European Congress of Chemical Engineering, Frankfurt-am-Main, Germany.

June 4–6

Gas Turbine Meeting, Faculté Polytechnique de Mons, Brussels, Belgium.

June 4–14

International Conference on Large Electrical Systems, Paris, France.

June 6–29

Seventh International Inventors' Exhibition, Institut des Arts et Métiers, Brussels, Belgium.

July 8–18

International Electrotechnical Commission, general meeting, Stockholm, Sweden.

(*ASME Coming Events, see page 138*)

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

ASME'S FIRST CONFERENCE OF 1958 HELD BY GTP DIVISION

Engineers of the Society's Gas Turbine Power Division, 800 strong, meet in Washington, D. C. Top military men hear Warren of G.E. speak at banquet.

THE winter cold wave had just abated. In the landscaped opulence of Washington's Shoreham Hotel, the ASME's Gas Turbine Power Division held its Annual Conference, March 2-6, 1958, the Society's first divisional conference of the year. The meeting, sponsored by The American Society of Mechanical Engineers with the co-operation of the Washington Section, brought together some 800 engineers engaged in the development and operation of this newest prime mover.

It was the third Annual Conference of this young group that achieved divisional status only ten years ago.

Among the registrants were 32 engineers from 11 foreign countries, and several of these engineers were here to present technical papers. The countries: Canada, England, Mexico, France, Turkey, Italy, Sweden, Germany, Switzerland, Australia, and . . . well, one engineer listed his home town as Hong Kong, and his country as Asia.

The men who design and build gas turbines—and many who operate the new power plants and who supply fuel—converged on the nation's capital to hear and discuss technical papers, to pool information, and to study an exhibition of gas-turbine engines and hardware unrivaled anywhere.

President Landis' Endorsement

In 1947, the gas-turbine engineers won their status as an ASME Division—won it over formidable opposition. In his speech at the banquet, ASME President J. N. Landis confessed that he had been among those who opposed the new division, believing its proponents could operate effectively as part of an already established group. But the gas-turbine men prevailed, and have since demonstrated the wisdom of their venture. Today, the youthful GTP is among the ASME's most vigorous and productive divisions.

"The lesson," said Mr. Landis, "is this: If you have a distinctly new technology, give it to new leaders."

In aviation, the gas turbine has reached the point where it stands alone in all planning for the next decade. It has become a leading contender for all large applications of motive power. Its place in stationary power—particularly in the process industries—becomes increasingly important.

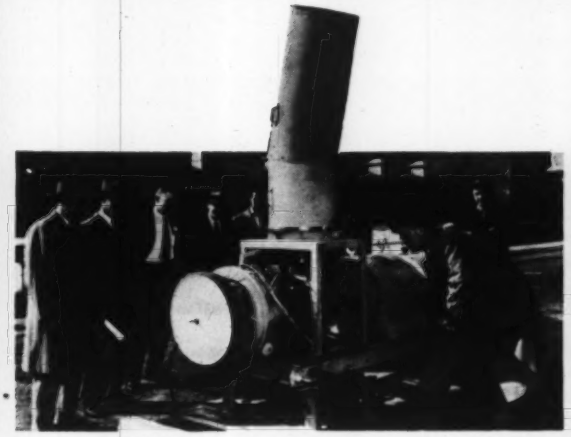
Turbines on Display

The exhibition, in the Shoreham's Main Ballroom, brought together samples of gas-turbine engines and hardware from foreign firms as well as our own leading manufacturers. There have been larger exhibits, such as those by the Air Force Association, limited to aircraft turbines and intended for the general public. But this was the outstanding exhibition covering gas turbines of all types, plus their equipment and metallurgy. It was a show for engineers.

The Napier exhibit, from England, featured their Eland turboprop engine which has been installed in the Convair airframe. Cleveland Diesel (GM) displayed a cutaway of the free-piston engine (the French SIGMA design). Boeing engineers at their exhibit answered questions about their new "turbo Tug," the lightweight, turbine-powered vehicle which can move giant aircraft. (The secret: Power rollers, pressed against the main wheels of the plane.) Lycoming's T-53, which will be used by the Navy in a hydrofoil high-speed boat, was on display, along with their new T-55, while General Electric presented its T-58 aircraft engine. Manufacturers of starters, pumps, clutches, electrical equipment, controls, and bearings offered their hardware for review and discussion.

Next Slide, Please

Monday morning, in the West Ball-



Scenes at the Capital Conference. ***Upper left:*** **Pay your fee and get your set of technical papers; also a ticket for the inspection trip to the Navy installation, a demonstration of the navy's experimental gas-turbine-driven units.** ***Above:*** **Boeing emergency generator, which can get under load quickly — no warm-up cycle, a notable virtue of the gas turbine.** ***Above right:*** **Ready to start a gas-turbine-driven fire pump, which sends forth a powerful stream of river water.** ***Right:*** **Engine room of the "Turbo Titan," General Motors' 200-hp gas-turbine tractor-trailer rig, so smooth the drivers doubt its acceleration until they time it.**

room, P. P. Nibley, Mem. ASME, of the Trans-Arabian Pipe Line Company, opened the technical sessions with his paper on gas turbines which pump oil across the desert and which operate unattended—started, controlled, and monitored by radio. Other papers presented at the Monday morning session came from General Electric and Westinghouse.

The afternoon session heard papers from Ruston and Hornsby, Ltd., General Electric, and la Société d'Études Mécaniques et Énergétiques. The evening session, taking up two papers on oil ash corrosion and treated vanadium fuel oil, developed into a spirited exchange between oil suppliers and gas-turbine builders and operators. There are strong differences of opinion on the control and analysis of residual oils.

Tuesday morning, engineers from General Electric, I-T-E Circuit Breaker Company, and Chesapeake Beach Naval Research Laboratory spoke before a packed hall. Papers covered technical developments in turbine design, and the design of the Comprex supercharger. The afternoon session heard from the University of Minnesota, and from Joseph Clark, Ltd., and C. A. Parsons & Company, Ltd., all on gas-turbine design. In the evening, attention turned to the steel industry's use of the gas turbine, papers emanating from Brown Boveri, Westinghouse, and U. S. Steel.

Thereafter, the technical papers fell into no group classifications. They covered all phases of the art, from the design of the T-58 to vibration control, from high-temperature alloys to nuclear-reactor turbines. Boeing, Naval Engineering Experimental Station, General Electric, Shell Petroleum, Ltd., Haynes Stellite Company, and the U. S. Atomic Energy Commission were represented.

Togetherness

The ladies found Washington attractive, and 42 of them accompanied their husbands to the Conference. Mrs. R. L. Goetzenberger and Mrs. H. D. Cather managed the women's program, which began on Monday with tea at the Embassy of Lebanon. Among the activities of the Woman's Auxiliary to the ASME is the provision of scholarships to foreign students who wish to study engineering in this country. Two young men from Lebanon are over here under such grants, and so it was that the visiting ladies were entertained at tea by the Ambassador's wife.

The women's program for Tuesday included a tour of Washington, and luncheon at the Kenwood Country Club. There was a coffee hour every morning at the ladies' headquarters in the Shoreham. Wednesday night was banquet night, and there the women joined their husbands in the Conference program.

Gas Turbines Join the Navy

Wednesday afternoon, ASME members and their guests were taken by bus past the famed Government buildings to the Naval Gun Factory where, as guests of the Department of Defense, they saw an exhibit of gas turbines under development by the Navy. This included a tour through a minesweeping boat which incorporated gas-turbine equipment, and a close look at the Chevrolet "Turbo-Titan" truck now under test by the Navy—a tractor-trailer rig in which the tractor engine is a 200-hp turbine.

Among the exhibits was an air-transportable pod containing a gas-turbine compressor for jet engine starting. Douglas had made the streamlined enclosure, and AiResearch Manufacturing Company, of Phoenix, Ariz., had built the turbine. The unit can be picked up under the wing of a fighter-type aircraft, and it can be carried in the bomb bay of the A3-D, providing air for engine starters up to 140 hp.

1 The first of the technical sessions. *Left to right:* P. P. Nibley of Trans-Arabian Pipe Line; H. D. McLean of General Electric; H. R. Hazard of Battelle Memorial Institute, and chairman of the Executive Committee of the GTP Division; R. E. Strong of Westinghouse; and C. S. Gerde of the U. S. Coast Guard, and vice-chairman of the session. 2 Mr. and Mrs. R. L. Goetzenberger. He is vice-president of Minneapolis-Honeywell, and she served on the Ladies' Committee for this Conference. 3 Mrs. D. M. Shackelford, first secretary of the Division, receives a citation from R. Tom Sawyer. 4 G. B. Warren, Director ASME, and vice-president of General Electric, delivers the main address at the banquet. 5 ASME President J. N. Landis presents a citation to L. F. Deming of the Department of the Navy. 6 L. N. Rowley, Director ASME, and editor and publisher of *Power*, speaking at an authors' breakfast.

Exhibits included turbines used for driving generators and fire pumps. With two or three such turbines in operation, the noise was such as to take off the top of your head. It is an old joke among turbine engineers that their machines can always be converted to air-raid sirens.

The Banqueteers

The banquet, held in the Terrace Room, Wednesday evening, constituted the great social gathering of the conferees and their wives, a glittering function in which high military officers sat at the head table with officers of the GTP Division and the ASME's Washington Section. J. N. Landis, President of the ASME, took part, and the main speaker was G. B. Warren, Fellow ASME, and vice-president of General Electric, who spoke on "The Versatile Power Plant."

President Landis, who is also a vice-president of Bechtel Corporation, presented a certificate to Leroy F. Deming, Mem. ASME, for "his valued services to the Division." The President then told briefly of the Division's stormy history, bringing out his point that a new technology should be in charge of its own dedicated leaders.

R. Tom Sawyer, who was the Division's first chairman, then presented a certificate to Mrs. D. M. Shackelford, the woman engineer who has served many years as secretary to the Division. She drafted the Division's first operating manual, which has since been expanded for all divisions. A member of the ASME staff, she continues her work with the ASME Standards Department.

The Versatile Power Plant

Main speech of the evening was by Mr. Warren, who recounted the history of gas turbines, a history in which he has taken an active part from earliest days. He worked with Dr. Moss, the man who developed the first airplane-engine supercharger (an exhaust-driven gas turbine driving a compressor) which made possible the altitude records set just after World War I. It was not until 1936 that the gas turbine became recognized as a machine with a future.

Mr. Warren's main thesis was the great versatility of the gas turbine. The original steam engine was not adapted to very large units in the electrical generating field. The steam turbine, ideal for large plants and for ships, was never

successful for road or rail transportation. The diesel, good in certain ranges, never challenged the steam turbine for large plants, nor has it been successful for aircraft or small road vehicles. It must burn premium fuel oil.

"In a period of about 15 years," Mr. Warren said, "the gas turbine has come close to pre-empting the entire military and civilian large, high-speed airplane propulsion field. In the field of land transport, it has had outstanding success as power for oil and gas pipelines, and some success in the locomotive field. Application has been made to merchant-marine propulsion, to small combat vessels, and to the automotive field. In the area of stationary power production, many applications have been made in industry and the electric utilities."

Mr. Warren looked to the day when "this business will be a profitable undertaking, filling its well-deserved place in meeting the growing power needs of the world."

Availability List— Gas Turbine Power Papers

The papers in this list are available in separate copy form until Jan. 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents to members; 50 cents to nonmembers.

Paper No.	Title and Author
58—GTP-1	A Model W-121 Gas Turbine for Power Generation and Mechanical Drive, by R. E. Strong
58—GTP-2	Rearrangement of the Temperature Field in Flow Around a Bend, by E. R. G. Eckert and T. F. Irvine, Jr.
58—GTP-3	New Gas Turbines for the Steel Industry, by Z. Stanley Stys
58—GTP-4	Operating Experience With 750/1000-kw Gas Turbines, by G. B. R. Feilden and T. P. Latimer
58—GTP-5	The Use of Adjustable-Stator Blades to Reduce the Idle Fuel Flow of a Simple-Cycle, Single-Shaft Gas Turbine, by C. Howard, Jr., and R. L. Hendrickson
58—GTP-6	Slipper Bearings and Vibration Control in Small Gas Turbines, by H. C. Hill
58—GTP-7	Accelerated Life Tests of a Pair of Naval Gas Turbines, by J. P. Pasman, C. L. Miller, and S. E. Fisher
58—GTP-8	Gas Turbines in the Arabian Desert, by W. E. Locher, A. E. Olson, and P. P. Nibley
58—GTP-9	Present State and Future Outlook of the Free-Piston Engine, by R. Huber
58—GTP-10	The Control of a Marine Gas Turbine, by F. H. Van Nest
58—GTP-11	Valveless-Gas-Turbine Combustors With Pressure Gain, by Carroll D. Porter
58—GTP-12	The "Auris" Gas-Turbine Project, by J. Lamb and L. Birts
58—GTP-13	The Performance and Reliability of Aero-Gas-Turbine Combustion Chambers, by J. S. Clarke and H. E. Lardge
58—GTP-14	Gas Turbines for Blast-Furnace Blowing, by G. H. Krapf and J. O. Stephens
58—GTP-15	Nonsteady Aerodynamics of the Comprex Supercharger, by Hans U. Burri
58—GTP-16	The Comprex—A New Concept of Diesel Supercharging, by Max Berchtold and F. J. Gardiner
58—GTP-17	The Effect of Treated High-Vanadium Fuel on Gas-Turbine Load, Efficiency, and Life, by B. O. Buckland
58—GTP-18	Operating Experience of General Electric Gas Turbines, by H. D. McLean
58—GTP-19	Small-Scale Burner Tests to Investigate Oil-Ash Corrosion, by R. C. Amero, A. G. Rocchini, and C. E. Trautman
58—GTP-20	Economic Considerations in Applying Gas Turbines to Electric Utility and Industrial Applications, by C. R. Dygert
58—GTP-21	Design Analysis of the General Electric T58 Engine, by F. W. Hegland

"Are You Making Your Cost Reduction Pay Off?" ASME-SAM Management Engineering Conference Asks

THE thirteenth annual Management Engineering Conference sponsored jointly by the Management Division of The American Society of Mechanical Engineers and the Society for the Advancement of Management will be under way Thursday and Friday, April 24 and 25, 1958, at the Hotel Statler, New York City. The conference theme has been developed around cost reduction and will feature papers and discussion on new techniques in industrial engineering, the most effective use of work-measurement dollars, measurement of nonrepetitive work, meeting challenges of wage incentives, and many others. Among the feature events of the conference will be a luncheon address on Thursday, April 24, by Robert W. Van Houten, president of Newark College of Engineering, on "A Little Sleep, A Little Slumber?" and a luncheon address on Friday, April 25, by James N. Landis, ASME President, on "A Functional Plan for the Engineering Profession."

Individual copies of the papers to be presented are not available; however, proceedings of the entire conference will be sent to each conference registrant. The proceeding will be available through the Society for the Advancement of Management, 74 Fifth Avenue, New York City 11, N. Y.

▶THURSDAY, APRIL 24

Session 1 **9:30 a.m.**

Developing Creativity in the Industrial Engineer, by *G. H. True,* University of Notre Dame, South Bend, Ind.

Industrial Engineering Approach to Control of the Engineering Function, by *J. S. Sayer,* E. I. du Pont de Nemours Co., Inc., Wilmington, Del.

Session 2 **9:30 a.m.**

How to Avoid Pitfalls When You Build Standard Data, by *Phil Carroll,* Maplewood, N. J.

Economics of Predetermined Times Versus Stop-Watch Times, by *G. E. Kane,* Lehigh University, Bethlehem, Pa.

Luncheon **12:15 p.m.**

Speaker: *Robert W. Van Houten*, president, Newark College of Engineering, Newark, N. J.

Subject: **A Little Sleep, A Little Slumber?**

Session 3 **2:30 p.m.**

Special Problems in Work Sampling, by *J. M. Allderige*, Eastman Kodak Co., Rochester, N. Y.

Case Studies in Maintenance Standards, by *C. C. Winston*, Ernst & Ernst, New York City

Session 4 **2:30 p.m.**

How to Measure Your Industrial-Engineering Performance, by *J. L. Schwab*, John L. Schwab Associates, Bridgeport, Conn.

How to Sell Your Industrial-Engineering Ideas, by *J. E. Judge*, Ford Motor Co., Dearborn, Mich.

▶FRIDAY, APRIL 25

Session 5 **9:30 a.m.**

Using Methods Engineering in Cost Reduction, by *R. D. McLandress*, General Motors Corp., Detroit, Mich.

Short Versus Long-Range Objectives of Cost Reduction, by *Ralph Presgrave*, J. D. Woods & Gordon Ltd., Toronto, Ont., Canada

Session 6 **9:30 a.m.**

Measurement of Manufacturing Indirect Labor, by *W. C. Cooling*, Engelhard Industries Inc., Newark, N. J.

Measurement of Clerical Labor, by *E. W. Gardiner*, Sears, Roebuck & Co., Boston, Mass.

Luncheon **12:15 p.m.**

Speaker: *James N. Landis*, Vice-President, Bechtel Corp., San Francisco, Calif., and ASME President

Subject: **A Functional Plan for the Engineering Profession**

Session 7 **2:30 p.m.**

Fundamentals and Control of Wage Incentives, by *B. A. Moski*, Yale & Towne Manufacturing Co., Philadelphia, Pa.

Multiple Factor Incentives, by *H. B. Brandt*, Procter & Gamble Co., Cincinnati, Ohio

Session 8 **2:30 p.m.**

The Foreman's Role in Industrial Engineering, by *R. T. Studer*, The Warner & Swasey Co., Cleveland, Ohio

The Unions Look at Industrial Engineering, by *David Lasser*, International Union of Electrical, Radio, and Machine Workers, AFL-CIO, Washington, D. C.

ASME OGP Conference in Philadelphia Again to Feature Industry-Wide Exhibit

Hilton Hotel in Houston, Texas, April 19–23.

SUNDAY, MAY 11

Registration **3:00 p.m. to 6:00 p.m.**

"Get Acquainted" Reception **4:00 p.m.**

▶MONDAY, MAY 12

Authors' Breakfast **8:00 a.m.**

Registration **8:30 a.m. to 3:00 p.m.**

OGP Exhibit **9:00 a.m. to 6:00 p.m.**

Session 1 **9:30 a.m.**

Chairman: *H. G. Braendel*, vice-president—engineering, Wilkening Manufacturing Co., Philadelphia, Pa.

Vice-Chairman: *R. L. Stanley*, executive secretary, Diesel Engine Manufacturers Assn., Washington, D. C.

Arctic Lubrication of Diesel Engines, by *E. J. Beck, Jr.*, Environmental Division, USN Civil Engineering Research and Evaluation Laboratory, Port Hieneme, Calif. (Paper No. 58—OGP-1)

Development of a Turbocharged Uniflow Two-Cycle Spark-Ignition Gas Engine,[1] by *W. M. Kauffmann*, Worthington Corp., Buffalo, N. Y.

Development of a Light-Weight High-Output Four-Cycle Diesel Engine for Naval Service, by *H. G. Holler*, Nordberg Manufacturing Co., Milwaukee, Wis., and *Laskar Wechsler*, Bureau of Ships, Department of the Navy, Washington, D. C. (Paper No. 58—OGP-2)

Exhibitors' Social Hour **11:45 a.m.**

Welcome Luncheon **12:30 p.m.**

Toastmaster: *L. M. Goldsmith*, general manager, engineering and construction, The Atlantic Refining Co., Philadelphia, Pa.

Welcome Address: *A. W. Weber*, vice-president, engineering and manufacturing, Corning Glass Works, Corning, N. Y., and Vice-President, Region III, ASME

Welcome Address: *Keeton Arnett*, executive vice-president, Greater Philadelphia Chamber of Commerce

Speaker: *James Creese*, president, Drexel Institute of Technology

Subject: **Educational Interest at Home and Abroad**

Session 2 **2:00 p.m.**

Chairman: *Dean A. Horn*, Commander, USN, Ships Design Division, Bureau of Ships, Department of the Navy, Washington, D. C.

Vice-Chairman: *W. K. Newcomb*, chief engineer, Ingersoll-Rand Co., Painted Post, N. Y.

The Bureau of Ships' Part in the Development of a Diesel Engine for the United States Navy, by *J. H. Reinertson*, Bureau of Ships, Department of the Navy, Washington, D. C. (Paper No. 58—OGP-9)

The U. S. Naval Engineering Experiment Station's Part in the Development of a Diesel Engine for the U. S. Navy, by *A. C. Cartleer*, Internal Combustion Engine Laboratory, U. S. Naval Engineering Experimental Station, Annapolis, Md. (Paper No. 58—OGP-8)

The Contractor's Part in the Development of a Diesel Engine for the U. S. Navy, by *A. K. Antonsen*, Fairbanks-Morse & Co., Beloit, Wis. (Paper No. 58—OGP-6)

THE thirtieth annual Oil and Gas Power Conference and Exhibit will be held at the Bellevue-Stratford Hotel in Philadelphia, Pa., May 12–15, 1958. Sponsored by the Oil and Gas Power Division of The American Society of Mechanical Engineers with the cooperation of the Philadelphia Section, the technical program, in seven sessions, will highlight the latest developments in this field.

The custom of having manufacturers in the field display their products and reports on recent developments has resulted in a closer tie-in between the engineers and industry. The Oil and Gas Power Exhibit has become an integral part of this conference. A person attending the Conference not only sees a vast variety of products in which he is interested, but makes worth-while contacts with the exhibitors' representatives.

The OGP Conference steadily gains professional approval and must plan far ahead; therefore it is appropriate to announce that the 1959 OGP Conference and Exhibit will be held at the Shamrock

Availability of Papers

ONLY *numbered* ASME papers in this program are available in separate copy form until March 1, 1959. Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Prices are 25 cents each to members of ASME, 50 cents each to nonmembers. Payment may be made by check, U. S. postage, free coupons, or coupons. Coupons may be purchased from the Society. The coupons in lots of ten are $2 to members, $4 to nonmembers. Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the conference.

[1] Paper not available—see box on this page.

▶TUESDAY, MAY 13

Authors' Breakfast **8:00 a.m.**

Registration **9:00 a.m. to 3:00 p.m.**

OGP Exhibit **9:00 a.m. to 6:00 p.m.**

Session 3 **9:30 a.m.**

Chairman: *John C. Geniesse*, manager, product development and technical services, The Atlantic Refining Co., Philadelphia, Pa.

Vice-Chairman: *F. M. Steele*, research engineer, The Hilliard Corp., Elmira, N. Y.

Lubrication of Large Diesel Cylinders, by *J. E. Cox* and *P. D. Hobson*, Martinez Research Laboratory, Shell Oil Co., Martinez, Calif. (Paper No. 58—OGP-3)

A New Look at Diesel Lubrication,[1] by *J. V. Kalb*, technical services division, and *S. M. Pier*, research division, Research and Technical Department, The Texas Co., Beacon, N. Y.

Performance of Economy Diesel Fuels in a Railroad-Locomotive-Type Diesel Engine,[1] by *T. A. Kramer* and *D. P. Osterhout, Jr.*, Socony Mobil Oil Co., Paulsboro, N. J.

Exhibitors' Social Hour **11:45 a.m.**

Session 4 **2:00 p.m.**

Panel Discussion: Maintenance of Fuel-Injection Systems

Chairman and Moderator: *Robert Cramer, Jr.*, chief technical engineer, Nordberg Manufacturing Co., Milwaukee, Wis.

Vice-Chairman: *T. O. Kuivinen*, chief engineer, Technical Division, The Cooper Bessemer Corp., Mt. Vernon, Ohio

Panel Members

Fred Behrens, service manager, American Bosch Div., Springfield, Mass.

Oscar A. Merian, field service representative, Scintilla Div., Bendix Aviation Corp., Sidney, N. Y.

Peter J. Sasgen, system diesel supervisor, The Pennsylvania Railroad Co., Philadelphia, Pa.

Fred Gossett, superintendent, Municipal Power Plant, Vero Beach, Fla.

Philadelphia Section Party **8:30 p.m.**

Monte Carlo Nite

▶WEDNESDAY, MAY 14

Authors' Breakfast **8:00 a.m.**

Registration **9:00 a.m. to 12:00 p.m.**

OGP Exhibit **9:00 a.m. to 12:30 p.m.**

Session 5 **9:30 a.m.**

Panel Discussion: Maintenance of Turbocharging Equipment

Chairman and Moderator: *B. P. Emerson*, editor, *Diesel Power*, Stamford, Conn.

Vice-Chairman: *W. C. Day*, manager, Gas Engineering, Columbia Gas System Service Corp., Columbus, Ohio

Panel Members

Benjamin Barish, manager, Power Systems Development Jet Division, Thompson Products, Inc., Willoughby, Ohio

K. A. Beier, vice-president, Research and Engineering, Schwitzer Corp., Indianapolis, Ind.

R. B. Miller, manager, Industrial Department, Aero Engineering Co., Hillside, Ill.

E. F. Lindsley, service engineer, White Motor Co., Cleveland, Ohio

R. F. Maiskiewicz, chief turbocharger engineer, The Elliott Co., Jeannette, Pa.

W. E. Irwin, service manager, Engine Division, Caterpillar Tractor Co., Peoria, Ill.

Inspection Trips

1:30 p.m. to 5:00 p.m.

The Atlantic Refining Company

The Philadelphia refinery of Atlantic is one of the most complete refineries. It has a daily capacity of six million gallons of crude oil. The trip will include a tour of the refinery and the research and development laboratories.

Reservations for trip may be made at Registration Desk. Declaration of citizenship or legally authorized presence in the United States is required by governmental regulation.

Westinghouse Gas Turbine Plant

1:30 p.m. to 5:00 p.m.

Lab stresses new designs and operating experiences. Three floors of experiments including: combustion lab, oil-treating lab, residual oil-firing installation, and compressor development and test.

Tour includes the possibility of seeing an actual gas turbine on test. Tour starts at the New Development Lab with a discussion of application of gas turbine to refinery operations and oil and gas production.

Exhibitors' Social Hour **6:00 p.m.**

Banquet (Informal Dress) **7:00 p.m.**

Toastmaster: *Arthur W. Weber*, vice-president, engineering and manufacturing, Corning Glass Works, and Vice-President, Region III, ASME

Citations for Outstanding Service to be presented to: *James C. Barnaby, Brian P. Emerson*, and *Hewitt A. Gehres*.

OGP Speaker's Award

Turbocharger Development for Loop-Scavenged Two-Cycle Gas Engines, by *J. D. Hines*, chief research engineer, and *Nelson Reed*, designer, rotating machinery, The Cooper Bessemer Corp., Mt. Vernon, Ohio

Speaker: *James N. Landis*, vice-president, Bechtel Corp., San Francisco, and ASME President

▶THURSDAY, MAY 15

Authors' Breakfast **8:00 a.m.**

Registration **9:00 a.m. to 12:00 p.m.**

OGP Exhibit **9:00 a.m. to 2:00 p.m.**

Session 6 **9:00 a.m.**

Chairman: *H. W. Whiting*, manager of engineering, Compressor and Engine Division, Worthington Corp., Buffalo, N. Y.

Vice-Chairman: *R. H. Beadle*, chief engineer, Diesel Division, Fairbanks, Morse & Co., Beloit, Wis.

A Method of Charge Stratification for Spark-Ignition Engines, by *L. E. Conta* and *P. Durbetaki*, The University of Rochester, Rochester, N. Y. (Paper No. 58—OGP-5)

Scientific Design of a Diesel Governor, by *A. G. Massey*, Marquette Division, Curtiss-Wright Corp., Watertown, N. Y., and *Rufus Oldenburger*, Purdue University, Lafayette, Ind. (Paper No. 58—OGP-1)

The Filtration of Diesel-Engine Oils, by *J. R. McCoy*, Indiana Commercial Filters Corp., Lebanon, Ind. (Paper No. 58—OGP-4)

Session 7 **1:30 p.m.**

Chairman: *Hsuan Yeh*, professor of mechanical engineering, University of Pennsylvania, Philadelphia, Pa.

Vice-Chairman: *H. Pofahl*, director of research, El Paso Natural Gas Co., El Paso, Texas

The Free-Piston Engine Possibilities, by *A. F. Moiroux*, engineer, La Société d'Études Mécaniques et Énergétiques, S.E.M.E., S.I.G.M.A., Paris, France. (Paper No. 58—OGP-7)

The Buchi Telescope-Valve System of Four-Cycle Diesel Engines, by *A. J. Buchi*, consulting engineer, Winterthur, Switzerland (Paper No. 58—OGP-10)

WOMEN'S PROGRAM

Sunday, May 11

"Get Acquainted" Reception

4:00 p.m. to 6:00 p.m.

Monday, May 12

Coffee Hour **9:30 a.m.**

Exhibitors' Social Hour **11:45 a.m.**

Welcome Luncheon **12:30 p.m.**

Tour **2:00 p.m.**

Tour of Cedar Grove, Mount Pleasant, and Lemon Hill, in Fairmount Park. Philadelphia colonial homes of the 18th century.

Tuesday, May 13

Coffee Hour **9:30 a.m.**

Valley Forge Trip **10:00 a.m.**

Bus trip to Valley Forge Park, including Washington's Headquarters and the Chapel. Lunch at General Wayne Inn, Merion, Pa., and then a visit to the Buten Galleries to see an extraordinary collection of Wedgwood.

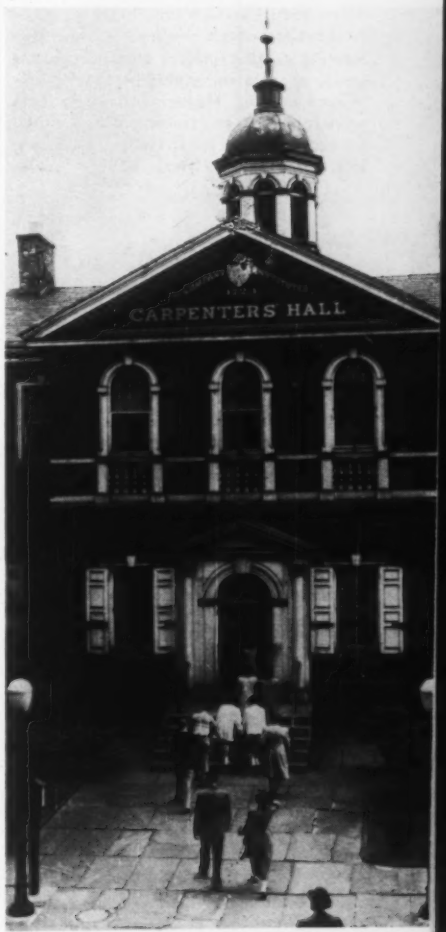
Monte Carlo Party **8:30 p.m.**

Wednesday, May 14

Coffee Hour **9:30 a.m.**

Philadelphia Art Museum **10:30 a.m.**

A general tour of the beautiful Philadelphia Museum of Art, including the famous Fashion Wing, and the Oriental Wing.



[1] Paper not available—see box on page 136.

ASME Power Division Makes Known 1958–1959 Conference Plans

THE Power Division of The American Society of Mechanical Engineers has long considered both the need and the practicability of including one or more power conferences in its annual program. Several other Professional Divisions have conducted such meetings in recent years, and with considerable success.

Division Conferences provide additional outlets for the presentation and discussion of technical papers, to some extent relieving the formidable congestion of technical sessions which has developed at the Annual and Semi-Annual meetings of the Society. Perhaps of equal value, they provide for smaller assemblages of engineers who have a common ground of major technical interest, and thus they promote an atmosphere of fellowship as they enhance acquaintance and understanding.

Power's first Conference was held in Allentown, Pa., October, 1957, with the Anthracite-Lehigh Valley Section performing as an excellent host. Problems arose, as was inevitable with the first of such events. However, most of them were related to an attendance level which far exceeded any predictions. Nevertheless, the meeting was handled well. Enthusiasm and audience participation ran high. It was demonstrated clearly that ASME-sponsored Power Conferences were off to a good start, and that they must play an important role in the Division's future programs.

The second conference of the Power Division will be held in Boston, Mass., from Sept. 28 to Oct. 1, 1958, with headquarters at the Hotel Statler. However, this will be a much larger meeting than that at Allentown, because it is aimed to represent the thermal power field broadly, rather than just the mechanical engineers' portion of that field. Indicative of this broadened scope, the Boston meeting will be known as the 1958 National Power Conference. It will be held under the joint auspices of the Power Division of both ASME and AIEE with the accredited engineering colleges of New England as co-operating sponsors, and active support will be provided by the Engineers Council of New England. Boston Sections of the two Founder Societies are co-operating fully in their common role of host.

Technical program subject matter has been established, ASME and AIEE committees having responsibility for approximately an equal number of the presentations. Seven consecutive technical sessions are now scheduled for the three-day program, therefore involving one evening session. Subject treatment has been framed to appeal to power engineers regardless of whether their primary concern is in the mechanical or electrical phase of power technology. In some instances, companion papers will be offered on the same general subject in order to present a diversification of viewpoints and practice. A complete set of papers will, of course, be provided upon registration. However, it is probable that these companion papers will be presented in technical sessions in digest form and by a "reporter," so as to leave ample time for audience participation in their discussion.

Plans are also now taking preliminary form for another Power Conference to be held in Kansas City, Mo., in the fall of 1959. There is every indication that the Power Division is now well under way toward establishing the conference-type of technical meeting on a continuing annual basis, and as a significant part of its service to members.—*C. B. Campbell*, ASME Power Division.

ASME COMING EVENTS

April 2–4

ASME Instruments and Regulators Conference, University of Delaware, Newark, Del.

April 9–10

ASME-AIEE Railroad Conference, Hotel Statler, Cleveland, Ohio

April 10

ASME Production Engineering Conference, Hotel Bancroft, Worcester, Mass.

April 14–15

ASME Maintenance and Plant Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

April 14–17

ASME Design Engineering Conference, International Amphitheater, Chicago, Ill.

April 15–17

ASME-AWS Metals Engineering Joint Conference, Hotel Statler, St. Louis, Mo.

April 24–25

ASME-SAM Management Conference, Hotel Statler, New York, N. Y.

May 11–15

ASME Oil and Gas Power Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Pa.

June 9–12

ASME Materials Handling Conference, Cleveland Auditorium, Cleveland, Ohio

June 11–14

Third U. S. Congress of Theoretical and Applied Mechanics, Brown University, Providence, R. I. (ASME is cosponsor.)

June 15–19

ASME Semi-Annual Meeting, Hotel Statler, Detroit, Mich.

August 18–21

ASME Heat Transfer-AIChE Conference, Northwestern University, Evanston, Ill.

September 4–5

ASME Second International Congress on Air Pollution, Hotel Statler, New York, N. Y.

September 8–9

ASME Applied Mechanics Western Conference, University of California, Los Angeles, Calif.

September 15–17

ASME Process Industries Conference, Hotel Statler, Buffalo, N. Y.

September 21–24

ASME Petroleum Mechanical Engineering Conference, Cosmopolitan Hotel, Denver, Colo.

September 28–October 1

ASME Power Conference, Hotel Statler, Boston, Mass.

October 9–10

ASME-AIME Fuels Conference, Hotel Chamberlain, Old Point Comfort, Va.

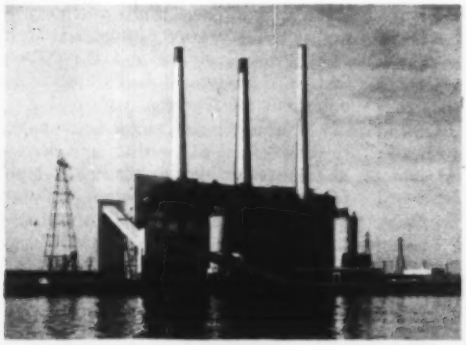
Note: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

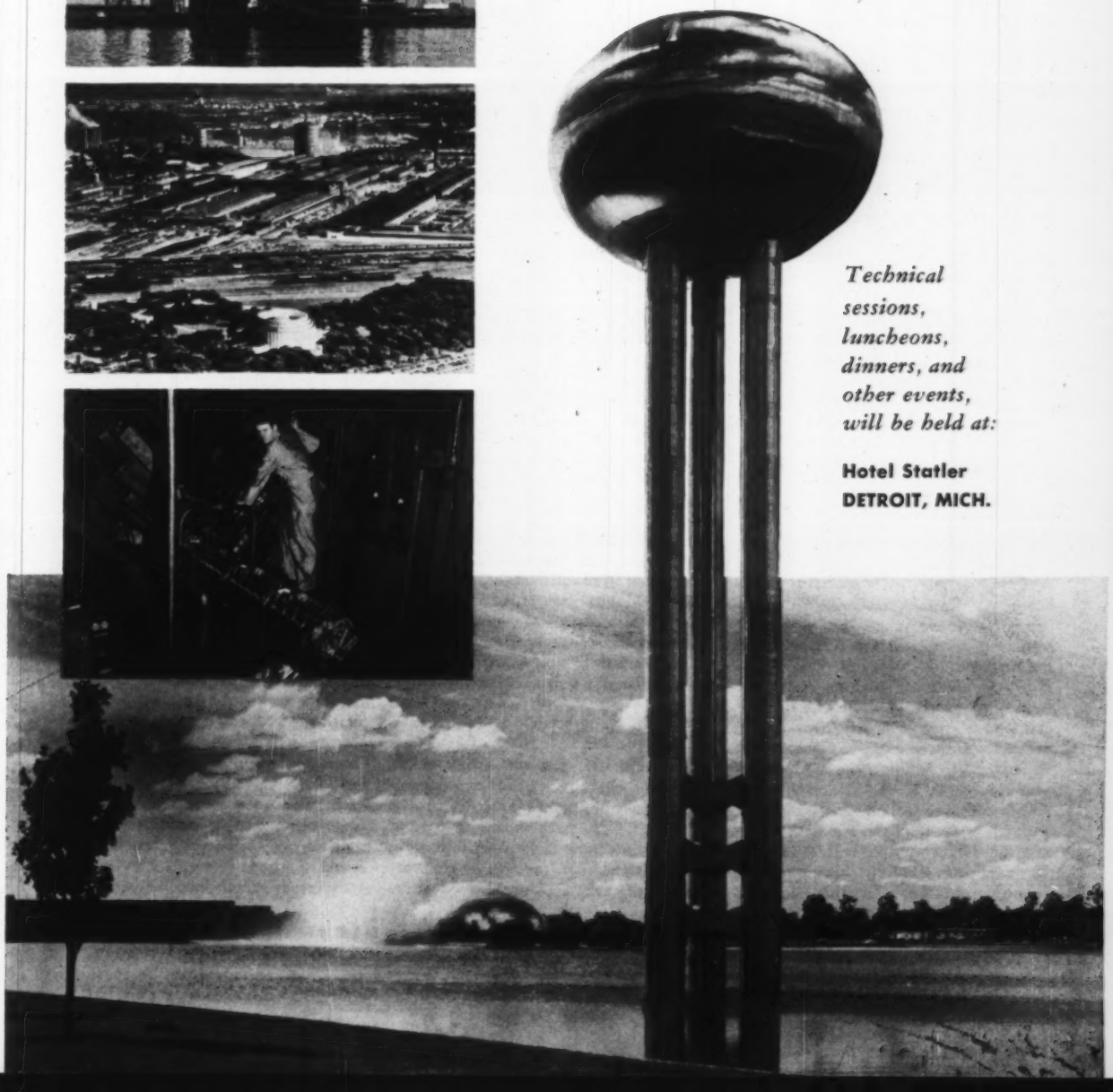
(*For Meetings of Other Societies, see page 131*)

1958 ASME Semi-Annual Meeting INSPECTION TRIPS

JUNE 15-19

Plants to be toured during ASME's coming Semi-Annual Meeting in Detroit, Mich., include, *top* to *bottom:* The River Rouge Plant, one of the most modern in the world and the largest electric power station in the Detroit Edison System; the Ford Motor Company's Rouge plant in Dearborn, Mich.; Chrysler Corporation's Mound Road engine plant; and General Motors Technical Center which is dominated by this 132-ft stainless steel clad water tower with a 250,000-gal capacity. In addition, the Enrico Fermi Atomic Power Plant, now under construction near Monroe, will also be visited.





Technical sessions, luncheons, dinners, and other events, will be held at:

Hotel Statler
DETROIT, MICH.

Industrial Engineering Intensive Courses Announced at Washington University

EIGHT Industrial Engineering Intensive Courses—Basic are being offered by the Department of Industrial Engineering and the University College at Washington University in St. Louis, from Sept. 8 through Sept. 19, 1958. They are intended for personnel desiring a *basic introduction to the subject* of the course.

These courses are being presented with the co-operation of the St. Louis chapters of the American Institute of Industrial Engineers, The American Society of Mechanical Engineers, the American Society of Tool Engineers, the American Society of Quality Control, the American Materials Handling Society, the Association for Computing Machinery, and the Society for Advancement of Management. For further information concerning course contents, instructors, and registration, write to University College, Washington University, St. Louis 5, Mo.

ASME Mid-Hudson Section Plans Steam Power Plant Design Conference

THE Mid-Hudson Section of The American Society of Mechanical Engineers is to hold a steam power plant design conference on May 8, 1958, at the Central Hudson Electric Building, Poughkeepsie, N. Y.

The technical program will deal with the design, construction, and operation of steam power stations and will reflect the opinion of leaders in this field. One session will be devoted to the development and design of a typical modern power station from preliminary study through first operation. Another session will discuss the design features of some modern steam stations, at the close of which there will be a discussion period.

Two inspection trips are scheduled. The first, on May 8, to Danskammer Station of Central Hudson Gas & Electric Corporation. The following day, the conferees will have the opportunity to see the Lovett Station of Rockland Light and Power Company and the Albany Station of Niagara Mohawk Power Corporation.

Ample hotel and motel accommodations are available within easy driving distance of the meeting place. No registration fees will be collected, and nonmembers of the Society are cordially invited to attend.

ASME Elects Four Members to Grade of Fellow

THE American Society of Mechanical Engineers has honored four of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow, one must be an engineer with acknowledged engineering attainment, have 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and be a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to and approved by the Council.

The men who were so honored for their outstanding contributions to their profession and to the Society are:

Irvin Henry Fullmer

IRVIN HENRY FULLMER, supervisory physicist, National Bureau of Standards, Washington, D. C., is a specialist in dimensional standardization. With the exception of one year spent in private consulting practice, he has been with the Bureau since 1917. He began as a laboratory assistant and assistant physicist preparing reports of dimensional gage calibrations. Subsequently, he was technical assistant to the section chief. When he returned to NBS in 1921, after a one-year absence, he became associate physicist in the gage section, and progressed through grades of physicist, senior physicist, and supervisory physicist. In 1954, he was appointed chief of the Engineering Metrology Section. His achievements in each of these capacities are numerous. Among his more important tasks were research on stud fits, which was the basis of a tentative classification; supervision of the precise calibration of tens of thousands of master precision gage blocks using optical interference methods; and the editing of several editions of the NBS screw-thread handbook. From 1945 to 1953, he served as chairman of the Federal Specifications Board Technical Committee on Bolts, Nuts, and Screws, and played a major part in preparing a large list of specifications. He was a delegate to the International Organization for Standardization conferences in Paris in 1949; in Zurich, 1950; New York, 1952; Stockholm, 1955. He is a member of the American Ordnance Association; the American Physical Society; the Philosophical Society of Washington; the Washington Academy of Sciences; Sigma Xi; and five ASA Sectional Committees, in addition to his membership in ASME. The Washington Section of the Society received his services as secretary, vice-chairman, and chairman, in 1931. He is the author of many articles which have appeared in technical publications.

Rawleigh M. Johnson

RAWLEIGH M. JOHNSON, engineer in charge of the engineering test department, Ingersoll-Rand Company, Phillipsburg, N. J., has been acclaimed for his achievements in the field of testing. His accomplishments in the area of performance testing as related to the production of steam turbines, centrifugal blowers, steam ejectors, reciprocating compressors, steam condensers, and diesel engines are equaled only by his efforts to train young engineers in the skills of such testing. Mr. Johnson joined Ingersoll-Rand in 1920 as a student engineer and progressed to his present position in 1929. The engineering test department, of which he has charge, specializes in conducting all tests for production, development, and research on compressors, condensers, pumps, turboblowers, and oil engines. He acts as a consultant on test problems and special investigations. It is among Mr. Johnson's functions to design test apparatus and select instruments and methods for tests. Under his direction, data were secured which led to the abandonment of the use of conventional tube packings on condenser tubes. Pressure-drop studies on model condensers provided necessary data for the design of large condenser-tube sheets to provide proper spacing of condenser tubes permitting rational steam flow. Formulas were developed which made it possible to design nonresonant pipe systems, now used as the basis of all performance testing on displacement compressors. These are but a few of the projects which have placed Mr. Johnson among the outstanding engineers of his time. Since 1935, he has contributed his services to the Society on test code assignments, and in 1955 was made the chairman of the Power Test Codes Committee.

Papers to which he has contributed

have appeared in ASME publications and in the technical press.

Louis N. Rowley

LOUIS N. ROWLEY, an engineer whose career has been devoted to technical publishing, is editor and publisher of *Power*, a McGraw-Hill publication in its 76th year. *Power* is an acknowledged leader in its field, not only in the United States but in all parts of the civilized world. To this pre-eminence Mr. Rowley has contributed in a major way during the 20 years of his association and particularly since 1945 when he first assumed managerial responsibilities. Among the significant services provided by the magazine, a service for which Mr. Rowley is largely responsible, is the preparation of special reports—concise treatises on current practice. These reports used as supplemental texts in the schools and in industrial training programs have had enormous influence on the education of an entire generation of power engineers. With Mr. Rowley as its editor, *Power* has launched such projects as the Modernization Award and the "Power to Grow . . . Electrically" programs. Through an extensive educational series, the nuclear energy seminars, it has brought a clear concept of the significance of nuclear energy to executives and engineers. An authority in the power field in general and specifically in the fields of internal-combustion engines and gas turbines, he has been a frequent lecturer on these subjects. He has been a guest lecturer on gas turbines at Columbia University. Before joining the *Power* staff in 1937, he was with the Brooklyn Edison Company and the Consolidated Edison Company of New York. His activities on behalf of the Society have been numerous. He served, for example, as secretary and chairman of the ASME Oil and Gas Power Division; member and chairman of the ASME Publications Committee, Gas Turbine Power Division, Board on Technology, Finance Committee, and Joint Committee, ASME and American Nuclear Society. He is presently a member of the Organization Committee and was, until 1956, on the Special Committee on Affiliations, and he is a newly elected Director (Administrative) of the Society. Mr. Rowley has been coauthor, with B. G. A. Skrotzki, Mem. ASME, and associate editor of *Power*, of several important technical papers published in the Transactions of the ASME, and he is the author of many articles and technical reports in *Power*. He is a member also of the American Nuclear Society, Tau Beta Pi, and Pi Tau Sigma. In 1957, he was elected an alumni trustee to the Corporation of the Polytechnic Institute of Brooklyn for a three-year term.

Fenton Benedict Turck

FENTON BENEDICT TURCK, president, F. B. Turck and Company, Inc., New York, N. Y., consulting engineers, is recognized for his contributions to the engineering profession for the development of original procedures and the application of engineering principles to such vital economic functions as distribution and marketing. These procedures have been put successfully into practice in the fields of diversification, distribution, and marketing by a number of corporations engaged in various lines of industrial activity. He has utilized these engineering techniques particularly in the steel-fabrication, building, chemical, electronics, and petroleum industries. As a consulting engineer, a lecturer, and an author, he has brought his views before leading executive, industrial, and professional groups throughout the country. He is the author of many papers on the subject of consulting engineering and the application of engineering principles to distribution and marketing. His career began with the American Radiator Company as a molder in the Bayonne, N. J., foundries; in 1928, before that company merged with Standard Sanitary Company, he was made vice-president. In 1932 the firm of Turck and Company was organized for the purpose of providing corporate sales service to individual companies. From this time until 1938, he maintained his connection with American Radiator and Standard Sanitary Corporation. He formed the industrial firm of Turck and Company, Inc., in 1938. In addition to the engineering work conducted by this firm for its industrial clients, the firm represents three large Netherlands financial interests in this country. Mr. Turck was decorated by the Dutch Government with the Order of the Office of Orange of Nassau. He has been a director and vice-president of R. F. Sedgley, Inc., and president of Williams Press; a director of McGraw-Hill Publishing Company, Inc.; and a director of the Holland House Corporation of the Netherlands. In 1951 he established the Turck Lectures on Distribution at Yale University. He has been active in fostering an exchange between engineers in America and abroad. He was an American delegate to the International Technical Congress in Paris in 1946, and took part in the organization of that body. As a direct result of discussions at the Congress, the World Engineering Conference was formed. Mr. Turck as a member of the EJC Committee on International Relations represented the United States at the first meeting of the WEC in 1946, and again in 1947. He served as a member of the WEC Council. He is chairman of the ASME Finance Committee for 1957–1958. He is a member of the American Institute of Consulting Engineers and of the Holland Society of New York. He is a member of the Newcomen Society and the American Association for the Advancement of Science.

ASME Approves Group-Insurance Program for Members

AFTER a year of comprehensive study, the Council of The American Society of Mechanical Engineers has approved the adoption of a group-insurance program available on a voluntary basis to its eligible members and their dependents. The program offers many advantages as compared with similar insurance available on an individual basis.

The idea of such a program was submitted to the Society early in 1956. Upon recommendation of the Vice-Presidents the subject was discussed at the Regional Administrative Committee Meetings in 1957, and at the Regional Delegates Conference in San Francisco, Calif., in June, 1957. Upon the latter's advice the Council appointed a three-man committee to investigate a suitable program for ASME members. The Committee members are Edgar J. Kates, consulting engineer, chairman: V. Weaver Smith, vice-president, Lummus Company; and Glenn B. Warren, vice-president and consulting engineer, General Electric Company.

This Committee, after careful consideration, submitted a favorable report at the November, 1957, meeting of the Council and received approval to complete the necessary steps in the selection of an insurance company and the details of the program, subject to the final approval of the Executive Committee. The Group Insurance Committee then negotiated a number of important improvements in the proposed program; the final program was approved by the Executive Committee on February 28, 1958.

The Group-Insurance Program consists of three basic Plans:

The Loss of Time Plan. With benefits for loss of time due to accident or sickness and accidental death or dismem-

berment. For ASME members only.

The Major Hospital Expense Plan. With benefits for hospital room and board, miscellaneous hospital expenses, nurse expense while in a hospital and after hospital confinement, and surgery. This plan will be offered with the option of either no deductible or $500 deductible coverage. It will be available to members and their spouses and children.

The Senior Hospital Expense Plan. With more limited benefits for hospital room and board, miscellaneous hospital expenses, nurse expense while in a hospital, and surgery. This plan is designed primarily for members of the Society over 70 and their spouses.

The program will be administered by Smith, Sternau & Son Corporation, of Washington, D. C., and underwritten by the American Casualty Company of Reading, Pa. The key personnel of the Administrator have successfully administered a similar plan for the American Society of Civil Engineers over the past nine years. They assure us that our members will at no time be approached through personal solicitation. Members will soon receive a mailing containing applications and full details of the plan.

There will be an open enrollment period of six months from the date of the first mailing. During that time, if 40 per cent of the enrolled members of any section (or of the entire ASME membership) apply for coverage, all applications received will be accepted regardless of the physical condition of the member (though members over 60 and impaired risks may be limited as to the extent of coverage they can purchase). If, however, less than 40 per cent of a local section applies, the company will have the privilege of refusing such applications from that section as it finds necessary due to the physical condition of the member (unless 40 per cent of the entire ASME membership has applied). (Any section with less than 100 members will be combined with another section for qualifica-

ASME CODES AND STANDARDS WORKSHOP

Interpretations of 1955 Code for Pressure Piping

FROM time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinions of the Committee.

Pending revision of the Code for Pressure Piping, ASA B31.1-1955, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Cases No. 30 and 32 are published herewith as interim actions of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

Case No. 30

Inquiry: May piping be designed and constructed under Division A of Section 3 and Section 5 of ASA B31.1-1955 Code for Pressure Piping, for service temperatures below −20 F?

Reply: It is the opinion of the Committee that piping within the scope of Division A of Section 3 and Section 5 of ASA B31.1-1955 may be designed and constructed for service temperatures below

CASE 30 Table 1

ASTM Specification	Material	Grade	Min Temp, °F	Max Allowable Stress (psi)
A193	Alloy Steel Bolting Materials for High-Temperature Service	B7	− 50	20000
		B7A	− 50	20000
A333	Seamless and Welded Steel Pipe for Low-Temperature Service	C	− 50	18350
		3	−150	21650
		5	−150	21650
A334	Seamless and Welded-Steel Tubes for Low-Temperature Service	C	− 50	18350
		3	−150	21650
		5	−150	21650
A312	Seamless and Welded Austenitic Stainless-Steel Pipe	TP 304	−325	18750
		TP 309	−325	18750
		TP 310	−325	18750
		TP 321	−325	18750
		TP 347	−325	18750
		TP 316	−325	18750
		TP 317	−325	18750
A358	Electric Fusion Welded Austenitic Chromium-Nickel Alloy Steel Pipe for High-Temperature Service	S	−325	16000
		M	−325	16000
		C	−325	16000
		T	−325	16000
		309	−325	16000
		310	−325	16000
A352	Ferritic Steel Castings for Pressure-Containing Parts Suitable for Low-Temperature Service	LCB	− 50	16250
		LC1	− 75	16250
		LC2	−100	16250
		LC3	−150	16250
A376	Seamless Austenitic Steel Pipe for High-Temperature Central Station Service	TP 304	−325	18750
		TP 321	−325	18750
		TP 316	−325	18750
		TP 347	−325	18750
A249	Welded Austenitic Stainless-Steel Boiler, Superheater, Heat Exchanger, and Condenser Tubes	TP 304	−325	16000
		TP 310	−325	16000
		TP 316	−325	16000
		TP 317	−325	16000
		TP 321	−325	16000
		TP 347	−325	16000
A271	Seamless Austenitic Chromium-Nickel Steel Still Tubes in Refinery Service	TP 304	−325	18750
		TP 321	−325	18750
		TP 347	−325	18750

tion purposes.) In the meantime, the insurance company has agreed to make the coverage effective for the insurable members after the first 100 acceptable applications from all sections of the Society have been received, so there will be no undue delay for those members who are acceptable.

The following are some of the outstanding advantages of this Group Insurance Program:

1 The Group Insurance Program will be offered to members at rates substantially lower than the cost of the same coverage under individual policies.
2 There will be no physical examination and the application will be an extremely simple one to fill out.
3 Once a certificate of insurance is validly in force, benefits cannot be reduced because of other insurance carried or because an insured performs duties of a more hazardous occupation.
4 The insurance program will provide world-wide coverage.
5 If sickness disability begins after the effective date of a certificate of insurance, coverage is provided, regardless of the date of origin of the ailment. Once a certificate is validly in force, it cannot be changed to eliminate coverage of this ailment.
6 A member and his spouse will be able to carry the Senior Hospital Expense Plan as long as they wish to continue coverage.
7 The Major Hospital Expense Plan will be available with the option of a $500 deductible, so as to eliminate duplication of benefits with a basic hospital expense plan a member may already carry.
8 Benefits from the Society's insurance program will be paid regardless of any other insurance which the member may be carrying so that if duplication is thought advisable, the additional protection is available (provided such duplication is permitted by the other insurance company).

The success of the Program will depend on the interest and active support of our membership. It is urged that each member give the matter serious consideration.

A269	Seamless and Welded Austenitic Stainless-Steel Tubing in General Service	TP 304	−325	18750
		TP 316	−325	18750
		TP 317	−325	18750
		TP 321	−325	18750
		TP 347	−325	18750
A182	Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves, and Parts in High-Temperature Service	F 304	−325	18750
		F 347	−325	18750
		F 321	−325	18750
		F 316	−325	18750
		F 310	−325	18750
		F 10	−325	18750
A350	Forged or Rolled Carbon and Alloy Steel Flanges, Forged Fittings and Valves, and Parts in Low-Temperature Service	LF 1	− 50	18750
		LF 3	−150	23250
A351	Ferritic and Austenitic Steel Castings for High-Temperature Service	CF8C	−325	17500
		CF8M	−325	17500
A300	Steel Plates for Pressure Vessels for Low-Temperature Service			
		Class 1	− 50	
	Flange or Firebox Qual.	A201A		13750
	Flange or Firebox Qual.	A201B		15000
		Class 2	− 75	
	Firebox Qual.	A203A		16250
	Firebox Qual.	A203B		17500
		Class 3	−150	
	Firebox Qual.	A203D		16250
	Firebox Qual.	A203E		17500
		Class 4	−320	
		A353		22500
A320	Alloy Steel Bolting Material in Low-Temperature Service:	L 7	−150	20000
		L 10	−150	20000
		L 43	−150	20000
		L 9	−225	20000
		B 8	−325	15000
		B8C	−325	15000
		B8P	−325	15000
B164	Nickel-Copper Alloy Forgings	A	−325	20000
B160	Nickel Forgings, Low-Carbon Nickel		−325	10000
B247	Aluminum Alloy Forgings	GS 11B	−325	9000
		GS 11A	−325	9500
	Aluminum Alloy Forgings	M1A	−325	3350

Note: In the above tabulation where the specification covers both seamless and welded pipe, only the stress value of the seamless material is shown. The stress value for welded pipe shall be the stress value of the seamless material multiplied by the following joint factor:

(a)	For Resistance Welded Pipe	Joint Factor 0.85
(b)	For Fusion Welded Pipe with weld metal deposited from one side only	Joint Factor 0.85
(c)	For Fusion Welded Pipe with weld metal deposited from both sides	Joint Factor 0.90
(d)	Where welded pipe joint is completely radiographed as required by the appropriate specifications	Joint Factor 1.00

Where the tabulated specification covers only welded material, the stress value shown includes the 0.85 joint factor.

−20 F provided that the following conditions are met:

1. The materials used for pressure-containing parts and stress-carrying structural elements intimately attached to the pipe shall conform to the appropriate specifications and shall be used within the indicated temperatures and stress limitations shown in Table 1.

2. All such materials shall be impact tested and meet the requirements of Par. UG-84 of Sec. VIII of the ASME Boiler and Pressure Vessel Code with the following exceptions:

a. Austenitic chromium-nickel steels with not more than 0.10 C except weld metal.

b. Nonferrous materials.

c. Bolting materials to ASTM A-193 B7 and B7A.

3. A set of test specimens shall be made to test the weld metal and the heat-affected zone of the base material for each range of $1/4$ in. of pipe thickness used.

4. Welded joints in piping which is to operate at temperatures below −20 F shall be stress relieved in accordance with the methods specified in Par. 632 of ASA B31.1-1955, except that those materials which are exempt from impact tests need not be stress relieved.

5. Thermal expansion data for materials in low-temperature services are given in Table 2.

6. Moduli of elasticity and torsional rigidity of ferrous and nonferrous materials in low-temperature services are given in Table 3.

Case No. 32

Inquiry: Is the use of centrifugally cast steel pipe permissible under Section 3 of ASA B31.1-1955 Code for Pressure Piping?

Reply: It is the opinion of the Committee that centrifugally cast steel pipe is suitable for use in piping systems under

CASE 30 Table 2*

A = Mean Coefficient of Thermal Expansion by 10^6 (in./in./° F)
B = Linear Thermal Expansion (in./100 ft)

Material	Coefficient	Temperature Range 70 to 200	−50 to 70	−150 to 70	−325 to 70
Carbon steel; Carbon-moly steel low-chrome steels (through 3 per cent Cr)	*A*	6.38	5.80	5.50	5.00
	B	0.99	0.84	1.45	2.37
Intermediate alloy steels: 5 Cr, Mo, through 9 Cr, Mo	*A*	6.04	5.45	5.20	4.70
	B	0.94	0.79	1.37	2.22
Austenitic stainless steels	*A*	9.34	8.90	8.60	8.15
	B	1.46		2.27	3.85
Straight chromium stainless steels; 12 Cr, 17 Cr, and 27 Cr	*A*	5.50	5.00	4.70	4.30
	B	0.86	0.72	1.24	2.04
25 Cr-20 Ni	*A*	7.76	7.20	6.85	6.35
	B	1.21	0.98	1.81	3.00
Monel 67 Ni-30 Cu	*A*	7.84	7.15	6.75	5.55
	B	1.22		1.79	2.62
Monel 66 Ni-29 Cr, Al	*A*	7.48	6.80	6.45	5.35
	B	1.17	0.98	1.70	2.53
Aluminum	*A*	12.95	11.60	10.90	9.90
	B	2.00	1.67	2.88	4.68
Gray cast iron	*A*	5.75			
	B	0.90			
Bronze	*A*	10.03	9.15	8.75	8.40
	B	1.56	1.32	2.31	3.98
Brass	*A*	9.76	8.95	8.50	8.20
	B	1.52	1.29	2.24	3.88
Wrought iron	*A*	7.32	6.65	6.30	5.70
	B	1.14	0.96	1.67	2.70
Copper-nickel (70-30)	*A*	8.54	7.80	7.40	6.65
	B	1.33	1.13	1.95	3.15

* These data are for information and it is not to be implied that materials are suitable for all the temperature ranges shown. Temperature limits are set out in Table 1 as revised in this case.

CASE 30 Table 3*

E = Modulus of Elasticity—multiply by 10^6
G = Modulus of Torsional Rigidity—multiply by 10^6

Material	Modulus	Temperature, Deg F 70	0	−100	−200	−325
Carbon steels with carbon content 0.30 per cent or less	*E*	27.9	28.6	29.0	29.5	30.0
	G	10.8	11.1	11.2	11.4	11.6
Carbon steels with carbon content above 0.30 per cent	*E*	29.9	30.2	30.4	30.6	31.0
	G	11.6	11.7	11.8	11.9	12.0
Carbon-moly steels, low Cr-moly steels through 3 per cent Cr	*E*	29.9	30.2	30.4	30.6	31.0
	G	11.6	11.7	11.8	11.9	12.0
Intermediate Cr-moly steels (5–9 per cent Cr), austenitic stainless steel	*E*	27.4	27.7	28.1	28.5	29.4
	G	10.6	10.7	10.9	11.0	11.4
Straight chromium stainless steel (12 Cr, 17 Cr, 27 Cr)	*E*	29.2	29.5	29.8	30.3	30.8
	G	11.4	11.5	11.6	11.8	12.0
Wrought iron	*E*	29.5	29.8	30.0	30.2	30.6
	G	11.8	11.9	12.0	12.1	12.2
Gray cast iron	*E*	13.4				
	G					
Monel 67 Ni-30 Cu	*E*	26.0	26.2	26.4	26.6	26.8
66 Ni-29 Cr, Al	*G*	9.5	9.6	9.7	9.7	9.8
Copper-nickel	*E*	18.9	19.2	19.5	20.0	20.5
80-20, 70-30	*G*					
Aluminum	*E*	10.6	10.7	10.9	11.1	11.3
	G	3.9	3.9	4.0	4.1	4.2
Copper	*E*	16.0	16.2	16.5	16.7	17.0
99.98 per cent Cu	*G*	6.0	6.1	6.2	6.3	6.4
Commercial brass	*E*	14.0	14.2	14.5	14.7	15.0
66 Cu, 34 Zn	*G*	5.3	5.4	5.5	5.6	5.7
Leaded tin bronze	*E*	13.0	13.2	13.5	13.8	14.2
88 Cu, 6 Zn, 1.5 Pb, 4.5 Zn	*G*	4.9	5.0	5.1	5.2	5.4

* These data are for information and it is not to be implied that materials are suitable for all the temperature ranges shown. Temperature limits are set out in Table 1 as revised in this case.

Section 3 of ASA B31.1-1955 Code for Pressure Piping if the following requirements are met:

1. The pipe shall meet the requirements of ASTM Specifications A216, A217 or A351 except that the hydrostatic test shall be as specified in Par. 6 of this case.

2. The pipe shall have both the inner and outer surfaces machined to a finish not coarser than 250 rms after heat treatment.

3. Each pipe after machining shall be examined on the inside and outside surfaces including ends by magnetic particle inspection or liquid penetrant method of surface inspection whichever is feasible for the material. When magnetic particle inspection is used it shall be made in accordance with ASTM E109 and defect revealed shall be repaired. When liquid penetrant method is used any crack-like defects revealed shall be repaired.

4. Each piece of ferritic alloy pipe having wall thickness greater than 1 in. shall be ultrasonically tested throughout its length after machining to determine its soundness by either the shear or longitudinal methods. Defects in excess of 5 per cent of the wall thickness shall not be permitted.

5. Austenitic castings are not amenable to ultrasonic inspection. Where specified on the purchase order pipe may be partially or completely radiographed. Pipe showing defects as judged by the Industrial Radiographic Standards for Steel Castings (ASTM E71, Cl. II) shall be repaired.

6. Each length of pipe after machining shall be tested by the manufacturer to a hydrostatic test pressure which will produce in the pipe, at room temperature, a stress of 90 per cent of the specified minimum yield strength. This pressure shall be determined by the formula:

$$P = 2st/D \text{ where:}$$

P = minimum hydrostatic test pressure (psi)
s = 90 per cent of the specified minimum yield point
t = actual wall thickness, in.
D = outside diameter of the pipe, in.

The test shall be maintained for not less than five (5) minutes.

7. Flattening test on pipe intended for bending or forming shall be made in accordance with Par. S3 of ASTM A362.

8. Minimum wall thickness of the casting shall be determined by the same formulas governing that of wrought steel pipe except that the permissible stress values shall be as shown in the appended table.

CASE 32—PART 1

Maximum Allowable Stress Values in Tension for Centrifugally Cast Steel Pipe, PSI

Material and Specification Number	Grade	Spec. Min. Tensile	Spec. Min. Yield	For Metal Temperatures Not Exceeding Deg F: −20 to 100	200	300	400	500	600	650	700	750	800
Carbon Steels													
A216	WCA	60000	30000	16900	16400	15800	15200	14650	13500	13500	12900	11650	9700
	WCB	70000	36000	20250	19500	18750	18000	17250	16500	15750	14950	13300	10800
Low-Alloy Steels													
A217	WC1	65000	35000	19500	18700	17900	17100	16250	15450	14650	14650	14650	14100
	WC4	70000	40000	21000	20150	19250	18400	17500	16650	15750	15750	15750	15300
	WC5	70000	40000	21000	20150	19250	18400	17500	16650	15750	15750	15750	15300
	WC6	70000	40000	21000	20150	19250	18400	17500	16650	15750	15750	15750	15300
	WC9	70000	40000	21000	20150	19250	18400	17500	16650	15750	15750	15750	15300
	C5	90000	60000	27000	25900	24750	23650	22500	21400	20250	19450	18350	17100
	C12	90000	60000	27000	25900	24750	23650	22500	21400	20250	19800	18900	17450
High-Alloy Steels													
A351	CA15	90000	65000	27000	25700	24450	23200	21950	20700	19450	18650	17650	16500
	CF8	70000	28000	15750	14850	13950	13050	12150	11250	10350	10150	10000	9800
	CF8M	70000	30000	16900	16350	15800	15200	14640	14100	13500	13250	12900	12600
	CF8C	70000	30000	16900	15850	14800	13800	12750	11750	10700	10550	10450	10350
	CH20	70000	30000	16900	16250	15600	14950	14300	13600	12950	12900	12850	12750
	CK20	65000	28000	15800	15350	14850	14400	13900	13450	12950	12900	12850	12750

Note: The above stress values include a casting quality factor of 90 per cent.

CASE 32—Part 2

Maximum Allowable Stress Values in Tension for Centrifugally Cast Steel Pipe, PSI

For Metal Temperature Not Exceeding Deg F

850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
7800	5850	4050	2250										
8350	5850	4050	2250										
12950	11250	9000	5650										
14200	12600	9000	4650										
14200	12600	9900	7000	4950	3600								
14200	12600	9900	7000	4950	3600								
14200	12600	9900	7000	5200	3800	2700	1800						
15300	12250	9000	6600	4700	3000	2000	1350						
15600	13500	10600	7650	4950	3000	2000	1350						
14400	9900	6850	4500	3000	2000	1350	900						
9600	9350	9100	8850	8650	6750	5200	4050	2950	2200	1600	1250	900	700
12150	11700	11100	10550	9550	8450	7200	6100	4750	3600	2700	2100	1650	1350
10200	10100	10000	9900	9800	9700	7200	4500	3250	2450	1800	1400	1100	900
12500	12150	11250	9450	7650	5850	4500	3400	2600	2100	1600	1150	800	700
12500	12150	11250	9900	8800	7650	6550	5400	4300	3150	2100	1450	1000	700

9. The foregoing requirements establish interim provision until such time as further ASTM Specifications on Centrifugally Cast Pipe, which the Committee understands are in preparation, become available and are accepted by this Committee.

Boiler and Pressure Vessel Committee To Meet in Minneapolis

A meeting of the Boiler and Pressure Vessel Committee of The American Society of Mechanical Engineers will be held jointly with the National Board of Boiler and Pressure Vessel Inspectors, April 22 to 25, 1958, inclusive, at the Radisson Hotel, Minneapolis, Minn.

Meetings will be held of the various subcommittees covering in part, power and heating boilers, material specifications, unfired pressure vessels, and welding. The National Board of Boiler and Pressure Vessel Inspectors will also hold sessions at this meeting. There will be an address by the Dean of the Institute of Technology of the University of Minnesota.

A dinner dance will be held on Wednesday and the all-day session of the Boiler and Pressure Vessel Committee is planned for Friday. Meetings of the various subcommittees as well as the Boiler and Pressure Vessel Committee are open to the public. The Committee holds six meetings a year, one of which is held out of New York City.

Representatives from the Boiler and Pressure Vessel Committee and the National Board of Boiler and Pressure Vessel Inspectors as well as Region VI comprise the Planning Committee.

New Appointment to Boiler and Pressure Vessel Committee

The appointment of James Madison Guy, Jr., as a member of the Boiler and Pressure Vessel Code, Main Committee, was announced on Jan. 3, 1958.

Mr. Guy is chief engineer of The Erie City Iron Works, Erie, Pa., and has a long career in all phases of boiler design, manufacture, and erection as well as extensive experience in plant layout and equipment research. Presently he is serving on the Subcommittee on Power Boilers and Subgroup on Fire Tube Boilers. Mr. Guy, Mem. ASME, is a registered engineer in the Commonwealth of Pennsylvania.

James Madison Guy, Jr.

Conducted for the National Junior Committee
N. J. VIEHMANN

JUNIOR FORUM

The Young Engineer in an Industrial Consulting Firm

By Bruce M. Bailey[2]

DURING the past year, this forum presented two articles which were, to me, particularly encouraging. The first was by a young mechanical engineer explaining the factors which led him into the teaching profession.[3] The second article described the variety of challenging problems facing a young engineer in one small company.[4] I found these encouraging because they provided a fresh approach to the problem of demonstrating the "professional attitude" in a young engineer. Both articles showed—in what I thought was a wonderfully clear manner—just what it was that the authors felt their careers offered in the way of professional and personal development.

I have often heard engineers—young and old alike—bemoan the fact that we don't seem to have the community status of doctors of medicine or, for that matter, of lawyers. If, in fact, such a comparison of community prestige between engineers and medical men is reasonable, then any inequalities must be no one's fault but our own. In any event, I hope to show here some of the possibilities for professional progress of a young engineer in a consulting firm; I'm quite certain that such a career course holds many parallels to that of a medical student as he proceeds from medical school to internship and finally full practice. The goal of the M.D. is that he be able to diagnose, prescribe for, and oversee the cure of illness; the full-fledged professional in engineering must similarly be able to perceive a need or a problem, develop—theoretically if necessary—a solution, and execute the solution to the technical and financial benefit of his client, whether the client is his own company or an outside industrial or government organization.

My own "internship" began with the NACA in the field of aerodynamics research. This was, for me, a stimulating area of work because of my undergraduate training in mechanical engineering and aeromechanics. I decided, after about two years, that I wanted to branch out more in the general field of thermodynamics and heat transfer and thus, ultimately, joined the staff of Arthur D. Little, Inc. (ADL), the contract research and development firm with whom I have been now for nearly five years. Clearly, however, internship had hardly begun. If I had been vague, fresh from undergraduate school, about the subtleties of subsonic boundary layers, then I was even less aware of the complications involved in developing a 180-liter-per-hour hydrogen liquefier to fit in the confines of *one* semitrailer!

Long, involved design calculations for heat exchangers for this unit were carried out under the direction of a senior ADL engineer. Through him I was able to gain some appreciation of techniques for thermally efficient heat transfer without excessive pressure drop in gas-to-gas exchangers. He also led the way for me in gas-liquefaction thermodynamic-cycle calculations aimed at optimizing systems for space, weight, power, or other reasons of economy. Of necessity, I had to learn methods for calculating certain thermodynamic properties of gases at low temperatures when available data were insufficient.

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After perhaps a year of pretty intensive work in this area, I found that, without senior help, I could dig into most problems of this type on my own. At last, then, it seemed as though the "medical school" phase was coming to a close and I could contemplate the prospect of being a bona-fide intern! This meant decreasing dependence on my seniors and more technical cognizance for me over the projects with which I was associated.

The variety of projects seemed to multiply rapidly, from unusual heat-exchanger designs, to development of air-cycle and "Freon"-type vapor-cycle cooling systems to remove heat from electronic equipment. In general, my work was divided into roughly two parts analytical and one part experimental; what a pleasure it can be to find, through experiment, that a fairly complex analysis yields reasonable predictions!

I learned, too, that as the young engineer at ADL develops familiarity not only with the detailed technical work but with company operations as a whole, he may begin to play a broader role in the over-all process of project work. He may be asked to contribute considerably to the development of proposals which are, of course, an essential part of contract research and development work. His role in describing possible technical approaches to the potential client's problem is often vitally important; in addition, because of his background, he frequently is in the best position to help develop estimates of just how much the work he wants to do will cost.

Finally, it became clear to me that doing the kind of work we like requires that we uncover the need for it, and here is where sales effort of one kind or another is all-important. We must become aware, somehow, of a present or potential client's need for our services. If the engineer at ADL has a good scheme for dealing with a problem, he must frequently carry his personal enthusiasm for the work directly to the would-be sponsor.

Perhaps case or project leadership marks the end of internship—the point at which we can, in effect, hang out our "shingle." It carries with it responsibility not only for the technical success of the project, but also for the proper alloca-

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[1] Development engineer, Western Electric Company, North Andover, Mass. Assoc. Mem. ASME.

[2] Mechanical engineer, Arthur D. Little, Inc., Cambridge, Mass. Assoc. Mem. ASME.

[3] R. P. Van Benschoten, "Young Mechanical Engineer in Teaching," MECHANICAL ENGINEERING, vol. 79, April, 1957, p. 414.

[4] R. A. Holstedt, "A Young Engineer in a Small Company," MECHANICAL ENGINEERING, vol. 79, May, 1957, p. 524.

tion of available funds, personnel, and many administrative essentials of the job. It means also, if the ultimate object of the work is a prototype system, responsibility for seeing that the completed system is satisfactory from the client's viewpoint. A lot of things are involved, and the challenges are stimulating.

Arthur D. Little, Inc., has an almost-overwhelming variety of activities in the general fields of science, technology, and management services. Many clients' needs can be satisfied only by combining, in any number of possible ways, the talents of personnel from any of these areas of work. I have found, a number of times, that working with my colleagues from other branches of the company's activity has offered valuable insight into the broader industrial scene.

In summary, it is easy to visualize how the professional development of the young engineer in a consulting firm may hold many parallels to the progress of a medical student as he proceeds through graduate school and internship to reach his M.D. status. I have also tried to indicate how, in a firm such as the one I am with, the tremendous diversity of its activities can present an ever-expanding scope of experience for the young engineer as he becomes more and more immersed in the company operations. The courses he may follow beyond his first direction of project work are several: continued growth as a "technical doer," a leader; parallel growth in sales and business development, or in general management areas; or combinations of these. Because of this, I feel that this type of career holds many of the features of work and opportunity that can give one a sense of being truly "professional."

Chairman's Corner

We, the young engineers, have before us the opportunity of participating with 286,000 engineers through United Engineering Trustees to obtain a $10 million United Engineering Center. The UET, composed of representatives of the Founder Engineering Societies including ASCE, AIME, ASME, AIEE, and AIChE, is erecting this center as the headquarters for 16 national engineering societies. It is our responsibility as ASME members to take an active part in this future of engineering. Each of us must contribute to assure success.

W. V. Chambers, chairman, National Junior Committee, ASME.

ACTIONS ASME EXECUTIVE COMMITTEE

A meeting of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the Society conference room, New York, N. Y., on Feb. 7, 1958. In addition to James N. Landis, chairman, who presided, there were present: E. W. Allardt, C. E. Crede, L. N. Rowley, and G. B. Warren, of the Executive Committee; W. H. Byrne, R. S. Stover, and A. W. Weber, vice-presidents; Joseph Pope and V. Weaver Smith, directors; E. J. Kates, treasurer; H. J. Bauer, assistant-treasurer; C. A. Jurgensen and W. H. Larkin, ASME Representatives to ECPD; O. B. Schier, II, secretary; T. A. Marshall, Jr., senior assistant secretary; D. C. A. Bosworth and W. E. Reaser, assistant secretaries; and Ernest Hartford, consultant.

The following actions of the Executive Committee are of general interest.

Death of Mae Pfuhler. The Committee noted with sorrow the death, on Jan. 24, 1958, of Mrs. Mae Pfuhler (Miss Mae Lenen) a member of the Secretary's staff for 38 years. (See Mechanical Engineering, March, 1958, p. 156.)

Translation of Russian Journal. It was announced that contracts have been completed for the translations of the Russian Journal of Applied Mathematics and Mechanics. (See Mechanical Engineering, March, 1958, p. 133.)

High-Temperature Steam Generation. The Secretary was authorized to sign a contract with the Department of Water and Power, City of Los Angeles, providing for a contribution of $1000 in return for progress and final reports on the work of the ASME Research Committee on High-Temperature Steam Generation.

Student Section. Approval was voted on the establishment of an ASME Student Section at the University of Houston, Houston, Texas.

Certificates of Award. The following Certificates of Award were granted:

To Harry McPherson and Kenneth E. Scott, retiring chairman of the Kansas City and Worcester Sections, respectively.

To R. E. Derby, chairman, 1955–1956, Philadelphia Section.

To Ralph E. Clarridge, chairman, Instruments and Regulators Division, 1955–1956.

Nonmember Committee Appointments. The Executive Committee accepted a report of the ASME Organization Committee relating to Society policy on appointment of non-ASME members on ASME committees. (A statement covering committee service, describing the manner in which committee personnel are selected and including statistics on nonmember appointments, with reason for their selection, is to be prepared for publication at a later date.—Editor.)

Actions ASME Executive Committee

A meeting of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the Society rooms, New York, N. Y., on February 28, 1958. In addition to the chairman, J. N. Landis, President ASME, there were present: E. W. Allardt, C. E. Crede, and G. B. Warren, of the Executive Committee; D. W. R. Morgan, past-president; W. H. Byrne, vice-president; R. B. Smith and V. Weaver Smith, directors; E. J. Kates, treasurer, H. J. Bauer, assistant treasurer; F. B. Turck, chairman, Finance Committee; O. B. Schier, II, secretary; T. A. Marshall, Jr., senior assistant secretary; W. E. Reaser, assistant secretary; J. J. Jaklitsch, Jr., editor; and Ernest Hartford, consultant. The following items are of general interest.

Dinner of UET, Engineering Foundation, and Library Board Representatives. Members of the Executive Committee met with representatives of United Engineering Trustees, Inc., The Engineering Foundation, and the Library Board at a dinner held at The Engineers' Club, Feb. 27, 1958. There were present: J. N. Landis, E. W. Allardt, C. E. Crede, L. N. Rowley, and G. B. Warren, of the Executive Committee; W. H. Byrne, D. W. R. Morgan, R. B. Smith, and V. Weaver Smith, of the ASME Council; F. L. Bradley, Organization Committee; E. J. Kates, treasurer; H. J. Bauer, assistant treasurer; O. B. Schier, II, secretary; T. A. Marshall, Jr., senior assistant secretary; W. J. Barrett, president, UET; C. E. Davies, executive director, United Engineering Center Project; S. W. Marras, secretary, UET; F. S. Blackall, jr., and H. E. Martin, ASME representatives, UET; E. M. Barber, ASME representative; and F. T. Sisco, director, The Engineering Foundation; F. M. Gil-

breth and W. L. Betts, ASME representatives, Library Board; and R. H. Phelps, director, Engineering Societies Library.

Power Division Custodian Fund. Establishment of a Custodian Fund for the Power Division was approved.

Meetings and Conferences. The following meetings and conferences were approved: Design Engineering Conference, April 14–17, 1958, Chicago, Ill.; Solar Energy Application Committee participation in the Solar House Symposium, Sept. 28 to Oct. 1, 1958, Phoenix, Ariz. (no expense to the Society); ASME cosponsorship of AIEE Conference on Automatic Techniques, spring of 1959, Chicago, Ill.

Maintenance and Plant Engineering Division. Formation of the Maintenance and Plant Engineering Professional Division was authorized. The scope of the new division is stated: (*a*) Managerial or control aspects, covering such items as organization, planning, scheduling, work-order systems, and maintenance history records; (*b*) mechanical analysis of maintenance problems, including development and use of instruments for diagnosing maintenance problems, diagnosing techniques and methods, and corrective actions; and (*c*) design modifications of equipment and facilities to reduce or eliminate maintenance problems.

The Executive Committee of the Maintenance and Plant Engineering Division was appointed as follows: Guerard Mackey, chairman, industrial engineer, du Pont de Nemours & Co., Inc., Wilmington 98, Del.; R. H. Moore, maintenance engineer, Philadelphia Electric Co., Philadelphia 48, Pa.; J. K. Bryan, mechanical development engineer, Union Electric Co., St. Louis 1, Mo.; B. G. Evans, manager, engineering maintenance departments, Eli Lilly Co., Indianapolis 6, Ind.; and K. P. Powers, staff product applications engineer, Gulf Research and Development Co., Pittsburgh 30, Pa.

1959 Technology Executives' Conference. It was voted that the 1959 Technology Executives' Conference will be held at Arden House, Harriman, N. Y., Feb. 8–10, 1959. The Executive Committee voted to meet at the same place, Feb. 6, 1959, and the vice-presidents on Feb. 7 and 8.

Special Committees Discharged. The following special committees of the Council were discharged: Society Income, Development Fund, and Policy of Recruiting Engineers at National Meetings.

Group Disability Insurance. The Executive Committee accepted the report of the Committee on Group Disability Insurance for ASME Members; approved sponsorship of a group-insurance program for ASME members as underwritten by American Casualty Company, to be administered by Smith, Sternau & Son Corp.; to appoint a Trustee to sign the application after approval by ASME counsel; to sign a document appointing Smith, Sternau & Son Corp., Washington, D. C., as administrator, and to arrange for any changes in such plans, its administrator, or the insurance carrier that may be decided by the ASME Council; and authorized publicizing the plan to ASME members at the expense of the administrator. (A statement on the Group Disability Insurance plan for ASME members will be found on page 141 of this issue—Editor).

Certificates of Award. Certificates of award were granted to the retiring chairmen of the Sections named: Cass F. Hurc (Rock River Valley); Fred Kamehameha Cordes (Hawaii); Clayton F. Nichols (Western Washington); and Carl J. Weingartner (Arizona). Certificates of award were also granted to William P. Gerhart and Henry B. Oatley, retiring members of the Boiler and Pressure Vessel Committee.

Engineering Societies Library. Approval was voted of an increase from 40 to 50 cents per member in the Library assessment; and ASME representatives on the Library Board were urged to submit a long-range plan giving concept and costs for providing adequate library services to the engineering profession.

United Engineering Center. Frank L. Bradley was designated vice-chairman of the ASME Member-Giving Committee for the proposed United Engineering Center in New York.

Niels Bohr International Gold Medal. The Institution of Danish Civil Engineers requested all member societies of EUSEC (Conference of Representatives from the Engineering Societies of Western Europe and the United States of America) to submit nominations for the Niels Bohr International Gold Medal for 1958. The Executive Committee made such a nomination.

Science Advisory Committee. It was voted to urge Engineers Joint Council to take a strong stand in a letter to President Eisenhower suggesting that there is an apparent overemphasis being placed on the pure sciences and a failure in many instances to recognize and consider the application of science—the province of the engineering profession.

Atomic Energy Commission. It was voted to suggest that Engineers Joint Council write to President Eisenhower to stress the importance of having adequate technical personnel on the U. S. Atomic Energy Commission. A slate of candidates was also suggested.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

NEW YORK	CHICAGO	DETROIT	SAN FRANCISCO
8 West 40 St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Mechanical Engineer, BSME, Iowa State College, 1955; 24; desires position in manufacturing and production leading to management. Has served as engineer officer aboard U.S. destroyer since graduation. Available early July. Location immaterial. Me-530-859-Chicago.

Mechanical, Industrial, or Management Engineer; 47; 24 years' experience in management, mechanical, tool, and industrial engineering. Solid background in machine and tool development. Location immaterial. Me-534.

Chief Engineer, ME; 35; 15 years in manufacturing engineering, production, tooling, processing, and machine design (automation). Location desired, Midwest or Pacific Coast. Me-535.

[1] All men listed hold some form of ASME membership.

Process or Development Engineer, BME; MME; 34; 12 years' experience; design heavy-machinery and process equipment for pulp and paper mills and building materials field. Also liaison between engineering department and shop, installation of equipment, and customer contact. Prefers New York City or Northern N. J. Me-536.

Industrial Engineer, BIE; 30; eight years' varied experience in materials flow, materials handling, scheduling, machine utilization, production control. As assistant to vice-president—operations, prepared costs and budgets, management controls. One year in systems and procedures including IBM conversion and feasibility studies for EDP. Me-537.

Mechanical Engineer, BS (ME); 30; three and one quarter years' experience in research and development, chemical processes; seven months in atomic ordnance evaluation; two and one-half years in metalworking, tool design, production processing, sales, supervision. Location immaterial. Me-538.

Manufacturing Engineer, MME; 33; ten years' varied production experience of diesel engines; textile machinery; ordnance stores—fuses and shells; special aptitude for single and multispindle automatics; prefers East. Me-539.

Industrial Engineer, BSME, MSME; 36; two and one half years in standard time-data development and one year of machine-shop time-study work. Prefers to locate in a city of over 300,000. Me-540-863-Chicago.

Mechanical Job-Leader Co-ordinator, EE, 1931; 48; 18 years' experience in piping design, planning, layout, and production drawings for refineries, petrochemical, and chemical plants. Managed men for 18 years, office and shop. Prefers Long Island, New York City. Me-541.

Mechanical Engineer, Product Development and Administration, BSME and SMNE; 40; 18 years' experience, seven supervision in mechanical-equipment development, design, production problems, shop and customer contacts, teaching, and management. Prefers East of Mississippi River. Me-542-9549-Detroit.

Automotive Engineer; 56; registered professional mechanical, electrical. Twenty years research, development, testing, field engineering, Washington military contact, on aircraft and automotive power plants and their equipment. Specialized on ignition and instrumentation. Prefers Detroit, Mich. Me-543-9570-Detroit.

Plant Management, BSME; 45; 23 years' experience in plant operations including production supervision, plant engineering, maintenance control, operations analysis, methods and cost studies, equipment requirements, and evaluation. Prefers Southeast. Me-544.

Chief or Senior Engineer, MSME; 52; steam-plant operation, five years; laboratory testing steam-plant components, two years; development and specifications for new steam-plant components, two years; administrative planning and scheduling, ship repairs, two years; operation large shipyard shops, two years; group study nuclear power plants, two years; consulting engineer, boiler manufacturer, one year. Prefers Rocky Mountain or Pacific Coast areas. Me-545.

Facilities, Plant, Liaison Engineer, BSME; 45; gas-turbine facilities engineer, five years; design-project engineer, research on aircraft propulsion, eight years; design engineer aircraft accessories, three and one half years; facilities engineering included test equipment for accessories. Prefers West. Me-546.

Production or Engineering Supervisor, BSME, BS Ind. Mgnt.; 37; shop tool-and-die experience. Supervised tool design, estimating, and scheduling in heavy metal fabrication of process machinery, unfired pressure vessels, and railroad equipment. Experience in personnel work, product development, plant layout, and equipment specifications. Me-547-871-Chicago.

Plant Engineer, Government school in Engineering; 37; plant and maintenance engineer, 14 years' experience; maintenance in general, construction, preventive program in maintenance, administrative duties, safety engineering; powerhouse operation and design. Location immaterial. Me-548.

General Manager; Vice-President, Manufacturing; or Manager of Manufacturing, BSME, MBA; 39; experience from machine operator to top management in manufacturing, labor relations, all phases of industrial engineering, and cost controls. Location immaterial. Me-549-873-Chicago.

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME _____ FIRST NAME _____ MIDDLE NAME _____

POSITION TITLE _____ NATURE OF WORK DONE _____

e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) _____ Division, if any _____

*☐

EMPLOYER'S ADDRESS _____ City _____ Zone _____ State _____

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g. Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

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Address changes effective when received prior to:

☐ MECHANICAL ENGINEERING	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ U—Maintenance and Plant Engineering
☐ D—Materials Handling	☐ M—Production Engineering	☐ V—Gas Turbine Power
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ W—Wood Industries
☐ F—Fuels	☐ O—Lubrication	☐ Y—Rubber and Plastics
☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	
	☐ R—Railroad	

Sales Engineer, 53; 25 years in marine and heavy industrial machinery sales and sales management. Considerable oil-field equipment experience. Registered professional engineer. Some design experience but desires sales or sales promotion. Prefers Gulf Coast area. Me-550.

Mechanical and Electrical Engineer, MS: graduated from Belgian University; 44; extensive experience in various fields, including fitting up of new plants, highly successful record in administration and supervision of engineering and maintenance of medium plants. Seeks position with progressive company. Me-551-996-San Francisco.

Mechanical Engineer, Manufacturing, BSME; 35; ten years' varied experience; production methods, electromechanical, and hydraulic design. Complete administering of manufacturing programs; design analysis, tooling, liaison, operation sheets, estimating, and trouble shooting. Prefers metropolitan New York or Long Island. Me-552.

Positions Available

Vice-President—Sales, graduate, to direct sales of large manufacturing company to process industries, power utilities, and consulting engineers. Experience in effective market research, forecasting, and sales-promotion techniques. $18,000, plus stock option participation and profit sharing. East. W-5808.

Research and Development Engineers. (*a*) Mechanical engineer, preferably with advanced degree, knowledge of gas dynamics, thermodynamics, and heat transfer; minimum of five years' experience in steam-turbine field; plus ability to conduct independent research and development work on steam turbines. (*b*) Mechanical engineer, preferably with advanced degree, with similar related experience in compressors. Salaries open. N. J. W-5851.

Instructors in Mechanical Engineering, graduate mechanical, preferably some teaching experience. School year 8½ months. Salary depending upon qualifications. Positions available September, 1958. W-5852.

Chief Industrial Engineer, 25–35, graduate industrial engineer, major in industrial economics, manufacturing, cost accounting. Prefer five to six years' experience. $8820–$10,800. Westchester County, N. Y. W-5854.

Research and Development Engineer, master's or PhD required in physics, electrical, aeronautical, or mechanical engineering, or mathematics, with analysis or theory or senior project work, for consulting-engineering company engaged in the technical direction of long-range missiles. Salary open. Calif. or Fla. W-5858.

Industrial Engineer, 30–40, to estimate production times, make production routings, including selection of machine tools to be used types of fixture and tools required for job. Set up time standards for cost control. Analyze methods for improvements. Apply statistical control procedures, where applicable. $7200. Southwest. W-5863.

Patent Attorney, mechanical-engineering background preferred, to prepare and prosecute applications for letters patent, trade-mark registration, and copyright by obtaining from personnel, information necessary for such applications, prepare and file the application, and prosecute the application to a final conclusion. Render opinion on scope, validity, infringement and title of patents, trade-mark registrations, and copyrights of the company and of others. Minimum of two years' experience in this field. $8000–$10,000. Upstate N. Y. W-5865.

Cable Engineer, at least three years' experience in design, development, and production of multiconductor cables. Electrical or mechanical engineering required. Will approve customer specifications and interpret same for quotation department, issue manufacturing specifications, supervise all cable operations on an engineering level. Will report directly to chief engineer. To start, $7000–$9000. Conn. W-5868.

Machine Designer, mechanical graduate, ten years' experience in design of packaging machinery and mechanisms, to design new machinery for particular applications and improve machines already in use. $9600–$12,000. Company may negotiate placement fee. Northern N. J. W-5874.

Senior Design or Project Engineer, graduate mechanical or electrical, sound knowledge of materials and methods or processes relating to boiler or pressure-vessel work. Must understand the low-pressure residential and commercial boiler business and the packaging of such equipment in either small boiler-burner units or packaged steam generators. Must be able to calculate the correctness of proportion, stress and efficiency, and such other data as may be required; should be able to prepare design or redesign details for boilers or similar items. Apply by letter, including salary requirements. Upstate N. Y. W-5883.

Mechanical Engineer, 30–50, BS, two to ten years' experience, preferably in the chemical industry with dust-control experience desirable. Duties will involve original estimate, design, and field follow-up of projects. Will participate in long-range programs in expanding engineering-design department. $7200–$10,800. Southern Conn. W-5885.

Painting Engineer, chemical or mechanical-engineering graduate, three to five years' experience, for fabricator of capital steel equipment, for work in coatings and painting. Must have had previous experience in this field. Staff work with seven plants. Salary open, dependingup on ability and experience; fringe benefits. Midwest. W-5886.

Consultant, graduate mechanical or electrical, 15 years' experience in hydro or steam-power engineering and design. Will head up large projects for well-known firm of consultants. Any public-utility experience desirable. Salary open. Considerable travel. Southwest. W-5887.

General Manager, Industrial-Products Division, preferably 35–45, engineering degree. Division concentrates on heat-transfer products for power-generating industry, primarily central-station steam condensers and related equipment. Specific experience in heat-transfer design or sales is especially desirable. Md. W-5888.

Junior Sales Engineer, graduate mechanical or electrical, some design or application experience on electromechanical products or servomechanisms. Some experience in application and/or sales of small electric motors also desirable. $6000–$7000. New York, N. Y. W-5895.

Teaching Personnel for Mechanical-Engineering Department. (*a*) Instructor or assistant professor in engineering graphics and drawing. Instructorship will carry privilege of fulfilling requirements for a master's degree at the rate of up to three courses a year. (*b*) Assistant professor or associate professor interested in teaching kinematics, mechanics of machines, and machine design. Master's degree required, experience in these topics desirable. (*a*) $5000–$6000; (*b*) $6000–$7000 for academic year. Available Sept. 1, 1958. Upstate N. Y. W-5900.

Instructors or Assistant Professors to teach applied mechanics, strength of materials, mechanisms, mechanical-engineering laboratory, or heat-power courses. Opportunity to work for master's degree. Rank and salary dependent upon experience and education. Available September, 1958. New England. W-5904.

Associate Professor or Professor for Mechanical-Engineering Department, who is interested in teaching machine design. Salary open. South. W-5909.

Development Engineer, Air Filters, preferably graduate mechanical, young, at least two years' experience in development or design work, preferably with air filters or closely allied products; aptitude for and interest in independent development work with minimum of supervision. Will act as project engineer in various air-filter development programs; assist technical director as technical adviser to sales and manufacturing departments, etc. $6500. Upstate N. Y. W-5912.

Assistant to General Manager who has had experience in a machine-jobbing shop specializing in precision machining of metal castings on jig borers, horizontal boring mills, milling machines, lathes, grinders, drill press, etc. Should have background that will enable applicant to take complete charge of the plant, estimating, sales engineering, and other functions. Approximately $10,000–$12,000. Vicinity of Newark, N. J. W-5913.

Sales Engineer, 30–50, minimum of five years' experience in field selling, preferably in aircraft-component parts or aircraft-engine experience, or fuel systems, valves, and the like. $7500–$9000, plus commission. Territory: Northeast and Middle Atlantic states. W-5915.

Senior Design Engineer, qualified to design and follow up the performance of printing presses especially for carton-board stock; select and install automatic machines to fabricate and fill packages; follow up performance and design improvements; direct design of light-duty automatic machinery for product manufacturer. Technical training, suitable actual experience, and definite leadership qualifications are required. Salary open. Midwest. W-5919.

Chief Engineer. Must be good manager and administrator, for large multiplant manufacturer of automotive equipment and parts. Must be able to deal with clients such as Ford, GM, or Chrysler and develop programs for new products, etc. $15,000, plus. Midwest. W-5927.

General Manager-Chief Engineer, mechanical graduate, to take complete charge of a new plant manufacturing refrigeration boxes or freezers. Knowledge of refrigeration and manufacture of this type of equipment necessary. To $20,000. Company will negotiate fee. South. W-5928.

Design Engineers, considerable analysis, design and/or supervisory training, and experience in the following fields: (*a*) Fluid components and packages (hydraulic valves, accumulators and reservoirs, hydraulic actuators, pneumatic actuators). (*b*) Fluid servo packages (electric and mechanical hydraulic servos, rotary and linear hydraulic actuators, multiple input hydraulic servos). (*c*) Thermodynamic devices (heat-transfer devices, small gas turbines, compressors and blowers, cooling systems). (*d*) Fluid pumps (centrifugal pumps, high-speed turbomachinery, positive displacement fluid pumps, motors, and accessories). (*e*) Senior product engineer, broad experience in design and manufacture of precision-hydraulic devices and components required. Salaries open. Mich. W-5933.

Director of Engineering, to 50, graduate mechanical, advanced degrees, competent to direct several engineering departments in product development and manufacturing engineering involving heaviest mechanical equipment and processes and heavy ordnance and defense products. Must have demonstrated administrative ability in large engineering organizations. $30,000–$35,000. New York, N. Y. W-5935.

Vice-President, Production, to about 50, graduate mechanical, experienced in heavy fabrication, forge and press work, and heavy machine-shop and foundry operations on multiplant basis; competent to direct product development, manufacturing engineering, and production of heavy mechanical assemblies; participate in sales and financial policies at highest levels. Base $40,000, plus. New York, N. Y. W-5936.

Director of Industrial Engineering, to 45, graduate mechanical or industrial engineer, experience in very heavy industry including steel fabrication, foundry and machine shops, storage and handling of heavy-steel shapes and plates, plant layout and normal industrial-engineering functions. Must be competent to administer industrial engineering for multiplant operations employing over 20,000. To $25,000. East. W-5937.

Development and Design Engineer, graduate mechanical, at least ten years' experience in the metal-cutting industry. Must have ability to design and lay out various types of machine tools; must be thoroughly familiar with all phases of machine design and have knowledge of hydraulic, electrical design, and automatic control. Conn. W-5945.

Engineers. (*a*) Research manager, engineering or physics graduate, PhD and at least ten years' supervisory experience in field of research covering weapons systems. (*b*) Senior research and development engineers, at least five years' supervisory experience in ballistic missile fields covering systems engineering, ground-support equipment, test planning, and instrumentation. $16,000–$22,000. West. W-5948.

Design Engineers, mechanical graduates, minimum of five years' experience in the design of high-speed precision assembly equipment. Mechanical inventiveness of high order required. Must be capable of board work as well as the follow through of supervising the fabrication of a piece of assembly equipment. To start, to $12,000. Central N. J. W-5954.

Assistant or Associate Professor, MS or PhD required, to teach graduate and undergraduate thermodynamics and fluid mechanics. Teaching or research experience highly desirable. Salary dependent upon qualifications. Midwest. W-5955.

Assistant or Associate Professor of Industrial Engineering, preferably PhD but will consider MS. Will take charge of curriculum in industrial engineering. Available September, 1958. New England. W-5956.

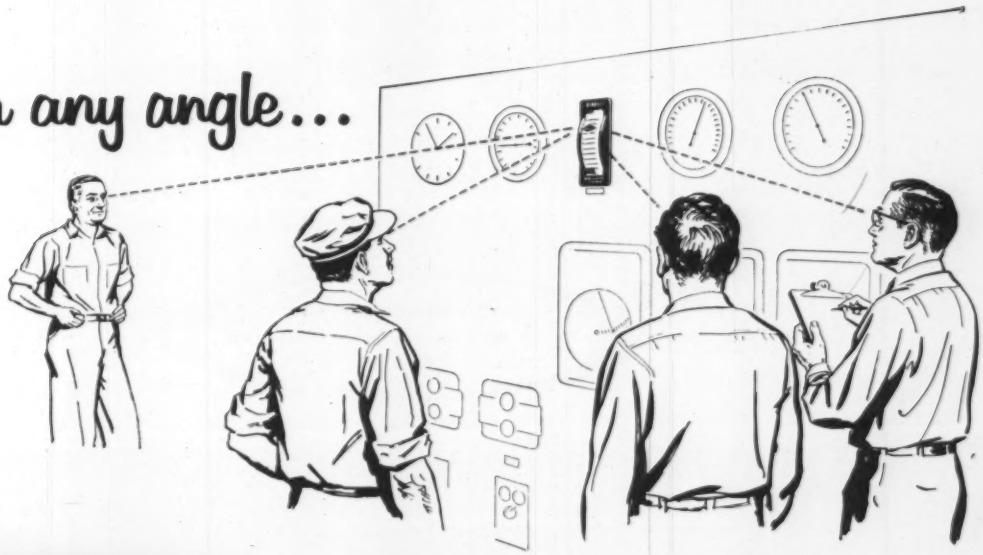
Engineers. (*a*) Chief engineer, special projects, mechanical graduate, 38–48, background in test facilities, design of jet engines, or a specialist in thermodynamics. Some direct experience in a missile program desired. Must have administrative ability. Will report to vice-president. $17,000–$20,000. (*b*) Project engineers on project level, 35–45, mechanical graduates, background as afore-mentioned. $12,000–$15,000. (*c*) Mechanical engineer, 35–45, experience in power generation, steam, electric, hydroelectric, to work on project level. Must be administrative type. $12,000–$15,000. New York, N. Y. W-5959.

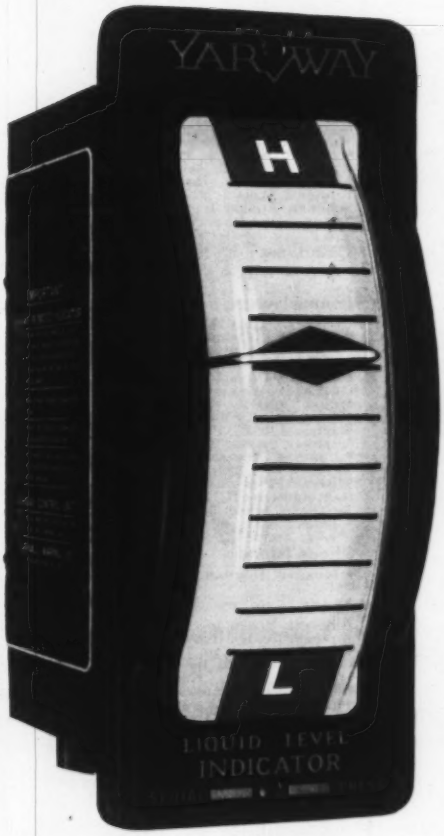
Senior Project Engineer, BSME, or at least two years' college education or equivalent, with practical experience in machine-shop work, to supervise, both directly and through others, specific designs, programs, or projects related to shop layout, machinery, and equipment, including tools, dies, jigs, etc.; to follow through to completion and place into operation assignments as may be assigned through plant engineer, assist in engineering studies related to or required by programs involving major or long-range renovation of facilities, etc. $7872–$9288. Pa. W-5963.

Management Consultants, 35–40, engineering degree, minimum of five years' experience with

(*ASME News continued on page 152*)

from any angle...





BOILER WATER LEVELS ARE EASIER TO READ with YARWAY INDICATORS

No matter where you stand, you can see at a glance your boiler water level in the Yarway Remote Liquid Level Indicator. The clear, "wide vision" face permits easy readings from any point in a 180° arc.

Readings are instant and accurate because the operating mechanism is actuated by the boiler water itself—by the pressure differential between a constant head and the varying head of water in the boiler drum. Pointer mechanism is never under pressure.

Yarway Remote Indicators are available fully compensated for every change in boiler temperature and pressure and they can be connected to Electronic Secondary Indicators or remote Hi-Lo Alarm Signals (lights or horns), located at any other point in the plant. Also available, Yarway Recorders working on same simple principle.

Over 12,000 Yarway Remote Indicators already installed.

Write for full details on Yarway Indicators for boilers, heaters and other applications. Bulletin WG-1824 tells all, shows typical hook-ups.

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YARWAY

...a good way to specify remote liquid level indicators

an important consulting company and a definite interest in making a career in the consulting field in Europe. Must have proved ability to obtain new business in the consulting field. Should be fluent in two of the following languages: English and/or French, German, Swedish, Spanish. Headquarters, New York, N. Y. F-5966.

Sales-Application Engineer, 25–35, degree in engineering, four or more years' experience in air-conditioning or related field. While either engineering or sales experience is acceptable, the former must have involved customer contact, the latter sales of a technical product. Will answer correspondence, phone calls, etc., make take-offs from plans, sizing products for proper application, pricing and quoting, etc. $5500–$6500. Conn. W-5971.

Designers, Senior and Junior, for architectural-engineering firm; mechanical, electrical, architectural, civil-architectural, under 40; recent graduates or one year's experience for juniors to do drafting and assist seniors. Minimum of four years' good experience for seniors with architectural-engineering offices in any of specialties; seniors capable of carrying their specialty (from start to final detail) in team effort; work experience required on commercial, industrial, general buildings, public and military buildings; must have architectural-engineering background; Calif. experience and knowledge of codes required. License or EIT desirable. Mechanical will include H&V, AC, plumbing, industrial piping. $5400–$8400. San Francisco. S-3393.

General Mill Foreman, Flotation, BS in metallurgical engineering required, preferably under 40. Must have eight years' operating experience, three years in supervisory capacity, for 3500 t/day copper plant. Southwest. S-3407.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after April 25, 1958, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and •Transfers

Alabama

COX, JULIUS G., Auburn
SCARBOROUGH, JOHN L., Auburn
WEAVER, WILLIAM R., Birmingham

Arizona

● BOZARTH, HAROLD H., Phoenix

Arkansas

WOODSMALL, WILLIAM M., JR., North Little Rock

California

BASHOR, MERLE S., San Fernando
● BOHMKE, WARREN F., Temple City
CAUDEL, FRED H., Martinez
CHANG, VAN PO, Los Angeles
GOOGIN, THOMAS M., Fairfax
● HEACOCK, JAMES H., Los Angeles
HUON, WILFRED A., San Francisco
LOVE, LOUIS E., Los Angeles
LUBELEY, ANTHONY J., Van Nuys
RINGELHEIM, ARNOLD H., North Hollywood
SCHONFELD, RONALD W., Los Angeles
SIRGO, HENRY F., Alameda
STADE, ARTHUR K., Whittier
YOSHIDA, RONALD Y., Van Nuys

Colorado

KAILUS, WILLIAM, Denver

Connecticut

BIGELOW, CHARLES G., JR., Greenwich
GRAND, PIERRE, New Haven
IVANKO, THEODORE, Fairfield
MOON, CLIFFORD G., JR., Hartford
● MURPHY, HUGH W., Stamford
REUSSER, PETER U., Ridgefield
TYNAN, DANIEL G., Trumbull
WELLS, CLIFFORD H., Clinton

District of Columbia

NAGELHOUT, RICHARD A., Washington
RATLIFF, WESLEY S., JR., Washington

Florida

CAMPBELL, JOSEPH W., Pensacola
COVINGTON, JIM H., Pensacola
FENDLEY, POPE, Port St. Joe
HOLT, DANIEL W., Chattahoochee
RADFORD, LUTHER E., Chattahoochee

Georgia

BRILLAT, ALPHONSE C., Atlanta

Illinois

BARNETT, RALPH L., Chicago
BOWMAN, CLETUS E., Urbana
● CUNNINGHAM, RICHARD G., Wood River
GRAMMER, LOUIS F., Metropolis
● MINDAK, ROBERT J., Chicago
RAYNOR, SEVERIN, Evanston
SALZENSTEIN, MARVIN A., Chicago
SCHLOSSER, VERNON I., Park Ridge

● Transfer to Member or Affiliate.

Indiana

BALLO, JAMES A., Fort Wayne
HOFFMAN, CLYDE H., South Bend
HUDSON, JOEL P., Indianapolis

Iowa

GRIFFITH, FRANK W., Sioux City
NORRIS, JOHN W., Marshalltown

Kansas

● NEVINS, RALPH G., JR., Manhattan

Kentucky

● FLINT, CHARLES V., Owensboro
SCHOLES, MED H., JR., Paducah

Louisiana

DOUGLAS, AUGUST H., JR., New Orleans

Maryland

BOND, JOHN R., Annapolis
HOLLIS, JERRY J., Silver Spring
HOPPS, GEORGE L., Silver Spring
MANOLL, ROY E., Wheaton
MCCARTY, GEORGE W., Towson
WELLS, GEOFFREY P., Frederick

Massachusetts

● CHASE, CHARLES C., Shrewsbury
NEALE, LAWRENCE C., Holden
PAGE, STANLEY E., Braintree
SEGIEN, RICHARD E., Boston

Michigan

DECKER, GERALD L., Saginaw
FORSTER, JAMES F., Detroit
GOSS, HUGH A., JR., Detroit
MACDONALD, GEORGE, Detroit
WATSON, JOHN D., Detroit

Minnesota

STRUTYNSKI, JOZEF S., Minneapolis

Missouri

● ACHESON, ALLEN M., Independence
BECK, HARRY W., Glendale
OETTING, ROBERT B., Rolla

New Jersey

● ANDERSON, ARTHUR R., Cedar Grove
BURRITT, LESLIE D., Linden
● CHAO, WU WAI, Upper Montclair
● FINNE, GILBERT L., South Plainfield
GALANDAK, JOHN, Upper Montclair
GRUTER, KLAUS, Union City
HARTUNG, HAROLD A., Collingswood
LONG, NOEL V., Somerville
SHEA, TIMOTHY E., Summit
SWED, RICHARD J., Lincoln Park
WESTOVER, ROBERT F., Murray Hill

New York

BAILEY, DONALD S., Tomkins Cove
BAUMANN, FREDERICK W., Schenectady
BEDELL, ROBERT K., New York
BORSCHEN, LUDWIG F., Carmel
COTTER, JOHN T., New York
FROHRIB, DARRELL A., Great Neck, L. I.
GERSTEN, RONALD D., Kew Gardens
GINN, WILLIAM S., Schenectady
HAMEISTER, HAROLD L., Ilion
● HOWITT, THOMAS, JR., Corning
HUTTENBACH, GUNTER W., Rochester
LIMON, LEONARD, Flushing
MARSHALL, EDWIN L., New Rochelle
MARZULLO, JOHN P., New York
MILLS, BERTRAND C., Schenectady
MORSE, SILAS L., New York
PRATT, MINOT H., Syracuse
SHAPIRO, WILBUR, Jackson Heights
SIEBEL, MATHIAS, New York
● STEWART, LAWSON E., Bedford Hills
VAN HEYST, HANS P., Fayetteville
● WINSTON, ARTHUR D., Brooklyn
YARDEN, URIEL, New York

North Carolina

HOYLE, GETTYS D., JR., Charlotte
PINKHAM, JESSE R., Raleigh
WATKINS, CHARLES E., Belmont

Ohio

ALBANESE, DAMIANO J., Cleveland
BABEL, HENRY W., Worthington
BETE, RAYMOND T., Cuyahoga Falls
DAVIS, SIDNEY O., Chillicothe
FLOUT, ANTHONY A., Canton
GOULDING, ALBERT, JR., Akron
HARDCASTLE, KENDRICK C., 3RD, Akron
● HOBBS, GEORGE S., Painesville
KACIR, IVAN R., Euclid
MIKELS, JOHN W., Akron
ROBERTS, DONALD L., Akron
SCHULER, ROBERT B., Columbus
THRONDSON, LESTER W., Westerville

Oklahoma

● SEATON, EARL A., JR., Tulsa

Pennsylvania

CHHABRA, DINA N., Bethlehem
● CLYMER, ELLWOOD A., JR., Glenside
COLE, CHARLES F., Reading
CURRY, SAMUEL B., Drexel Hill
FONTAINE, DONALD C., Chester
GEARHART, WILLIAM F., Latrobe
HUDAK, JOHN R., Erie
JAIN, SHANT K., Pittsburgh
KAPILA, AJIT K., Pittsburgh
KASHYAP, SHASHI K., Pittsburgh
● LEMEZIS, SYLVESTER, JR., Lester
LESKO, REGIS J., Homestead
MOFFETT, DONALD W., Pittsburgh
RAO, ASWATHA N., Pittsburgh
SMELTZER, ALTON B., Pittsburgh
● WILSON, CARL D., Coraopolis

Rhode Island

● MOREAU, NORMAN, Pawtucket

Texas

BENNETT, LLOYD J., Houston
BURGER, JOE R., Houston
● DELONG, RALEIGH, JR., Texas City
GENTRY, JOHN W., JR., Houston
HARTWELL, JOE D., Houston
MCLAREN, CORNELIUS F., JR., Houston
PHILLIPS, SAMUEL R., Houston
SCHWEPPE, JOSEPH L., Houston
SEGL, WALTER E., JR., Fort Worth

Vermont

ANDERSON, GORDON R., JR., St. Johnsbury

Virginia

FARLEY, ERNST W., JR., Richmond
JOHNSON, LINWOOD E., Arlington
MITTENDORFF, EDWARD M., Charlottesville
SCHUTTE, LAWRENCE E., Hopewell

Washington

REIGHTLEY, DONALD R., Bellevue
WU, JAMES C. Y., Spokane

West Virginia

COLE, ALLAN W., South Charleston
FORTNEY, EUGENE O., South Charleston
PARSONS, WILLIAM D., Charleston

(ASME News continued on page 154)

compact, efficient,
mass produced for
quick delivery

a new P-K product line you'll want to know about— and the new P-K catalog that describes it

—YOURS FOR THE ASKING!

The P-K Type DW convertor and water heater is for use below the water line of steam or hot water boilers. It is engineered for high heat transfer and low maintenance and the design is standardized for a complete selection of sizes – capacities – temperature ranges – for industrial and domestic "water to water" heat applications.

Mail the coupon now for complete description, including capacity and dimensional tables of sizes available for fast delivery. The Patterson-Kelley Co., Inc., 2404 Warren St., East Stroudsburg, Penna.

Patterson-Kelley Co., Inc.
2404 Warren St., East Stroudsburg, Penna.
Send me a copy of Bulletin No. 6050 on the new P-K Type DW convertor and water heater.

*Name*_____ *Title*_____

*Company*_____

*Address*_____

*City*_____ *Zone*____ *State*_____

Patterson Kelley

Water Heater Division

Storage Water Heaters • Instantaneous Heaters Convertors • Fuel Oil Heaters

Wisconsin

● Davis, Calvin R., Jr., Brookfield
Draeger, John K., Janesville
Flannery, James N., Milwaukee
Klinkenberg, Hubert E., Beloit
Trunk, Edward V., Milwaukee
● Ziering, Marvin B., Milwaukee

Foreign

Austin, Albert J., Maracaibo, Venezuela, S. A.
● Chapin, B. R., Toronto, Ont., Canada
Csathy, Denes, St. Catharines, Ont., Canada
Erwin, James M., New Delhi, India
Milligan, Frank C., Toronto, Ont., Canada
Pattillo, Alexander Y., Valparaiso, Chile, S. A.
Rogers, David G., Edmundston, N. B., Canada
Till, Arnold, Hamilton, Ont., Canada
Wright, Sherwin H., Melbourne, Vic., Australia

OBITUARIES

Stellan Birkland (1894–1957), engineer in charge of design, San Francisco Machine Shop, American Can Co., San Francisco, Calif., died Dec. 11, 1957. Born, Gothenburg, Sweden, Sept. 6, 1894. Parents, Sven Edward and Ida Charlotte (Malgren) Bjorklund. Naturalized U. S. citizen, San Francisco, Calif., 1931. Education, ME, Chalmers' Technical College, 1916. Married Eleonora Johansson, 1917. Junior ASME, 1927; Assoc-Mem. ASME, 1929; Mem. ASME, 1935. Mr. Birkland who had been with the American Can Co. since 1924, held a patent for an automatic can-sealing machine. Survived by his widow and a daughter, Bergit.

William G. Born (1879–1957?), whose death recently was made known to the Society, had been retired in Miami, Fla. Born, Neuruppin, Brandenburg, Germany, Aug. 27, 1879. Parents, William and Clara Born. Education, Academy at Cothen; ME, University of Dresden, 1902. Naturalized U. S. citizen, Chicago, Ill., 1919. Married Amelia Born, 1905; five children, Leroy, Earl, William, John E., and Loretta. Mem. ASME, 1919. Before his retirement, Mr. Born had been with John Mohr and Sons, Chicago, Ill., since 1905. He held several patents including such items as a hot metal mixer, a milk sterilizer, and tie and timber-treating machines.

Henry Weil Butler (1877–1957), former partner in Sanderson and Porter, engineers and constructors, New York, N. Y., died Dec. 25, 1957. Born, New York, N. Y., Sept. 12, 1877. Education, ME, Cornell University, 1900. Mem. ASME, 1924. Mr. Butler served as assistant to the chief engineer of the IRT power station and as engineering manager of J. G. White Engineering Corp., before joining Sanderson and Porter in 1921. He retired in 1948. During World War I, he served as a captain in the Bureau of Aircraft Production. From 1927 to 1935, Mr. Butler served as a member of the ASME Admissions Committee. Survived by his son, Jonathan Fairchild Butler, and a daughter, Mrs. Sally Butler-Hoge, Londonderry, Va.

Harold Elmer Erb (1897–1957), chief engineer, Prudential Life Insurance Co., Newark, N. J., died Nov. 6, 1957. Born, East Greenville, Pa., Sept. 21, 1897. Parents, Elmer Ellsworth and Agnes (Miller) Erb. Education, BS(ME), Pennsylvania State University, 1918. Married Adele Woodhouse, 1929. Mem. ASME, 1938. In 1946, the Congress of the United States presented him with a Certificate of Merit and The Selective Service Medal for "loyal and faithful adherence to duty given voluntarily and without compensation to the impartial administration of the Selective Service. . . ." Survived by his widow and a daughter, Mrs. Joseph Paul Thorne. Member Sigma Tau.

Ernest Elliot Hess (1888–1957), checker, Lufkin Foundry and Machine Co., Lufkin, Texas, died Sept. 29, 1957. Born, Bloomingburg, Ohio, Nov. 14, 1888. Parents, Evan and C. M. Hess. Education, BS(EE), Rose Polytechnic Institute, 1915. Junior ASME, 1917; Assoc-Mem. ASME, 1925; Mem. ASME, 1935.

Thomas Ormond Hussey (1886–1957), maintenance engineer, Public Buildings Administration, Federal Works Agency, New York, N. Y., died Dec. 17, 1957. Born, Savannah, Ga., Oct. 8, 1886. Education, BS(ME), Cornell University, 1912. Mem. ASME, 1941.

Thomas McLean Jasper (1882–1957), engineering consultant, A. O. Smith Corp., Milwaukee, Wis., died Aug. 3, 1957. Born, Tregunnon, Cornwall, England, Dec. 25, 1882. Parents, Richard and Lucinda (McLean) Jasper. Education, BS, East Cornwall College, England, 1910; MS, 1911; CE, University of Illinois, 1921. Mem. ASME, 1926. Married Hilda Gwendolyn Julian, 1913; one son, Arthur McLean Jasper. Mr. Jasper had been with the A. O. Smith Corp. since 1926. He was the author of numerous articles in technical and professional magazines and papers and discussions before professional and learned societies. Member Sigma Xi.

Otto von Kories (1888–1957), project engineer, Midland Rubber Corp., Los Angeles, Calif., died Dec. 6, 1957. Born, Hamburg, Germany, May 17, 1888. Education, Engineers' Preparatory School, Hamburg, Germany; ME, Technicum at Bingen, 1906. Naturalized U. S. citizen. A diesel-engine expert, Mr. Kories had been an inventor and was working on the construction of an experimental gas turbine for automobiles as early as 1922. He held patents on several diesel and gas engines in South America and Germany. Mem. ASME, 1942.

James T. Lawson (1879–1957), assistant to general superintendent of generation, electrical department, Public Service Electric and Gas Co., Short Hills, N. J., died Dec. 12, 1957. Born, Jersey City, N. J., April 23, 1879. Education, high-school graduate, attended Stevens Institute of Technology. Mr. Lawson joined the Public Service Electric Co., Newark, N. J., in 1898. Assoc.-Mem. ASME, 1915; Mem. ASME, 1919.

Luke John Martin (1920–1957), property and evaluation engineer, Commercial Solvent Corp., Terre Haute, Ind., died Aug. 4, 1957. Born, Kaukauna, Wis., March 26, 1920. Parents, Mathew and Clara Martin. Education, Illinois Institute of Technology. Assoc. Mem. ASME, 1950. Married Mary Raybould, 1954. During World War II, Mr. Martin had been a Captain in the U. S. Army Air Force. Survived by his widow.

George Ellis Miller, Jr. (1928–1957), Adache Associates, Inc., Cleveland, Ohio, died Aug. 3, 1957. Born, Pigua, Ohio, April 27, 1928. Parents, George Ellis and Helen Virginia Miller. Education, BS(ME), University of Cincinnati, 1952. Married Joanne Lee Clover, 1952; two children, Sheila Ann and Karen Lee. Assoc. Mem. ASME, 1951. Survived by his widow and two daughters. Member of Tau Beta Pi and Pi Tau Sigma.

Leclanche Moen (1881–1957), retired partner in McClure Jones and Co., New York, N. Y., died Nov. 23, 1957. Born, New York, N. Y., March 4, 1881. Parents, Edward Arthur and Mary (Cram) Moen. Education, BS(ME), Columbia University, 1903. Married Margaret M. Jones, 1906. Mr. Moen has been connected with investment banking since 1919. He was successively with John Burnham and Co., Chicago, Prince and Whitely, and McClure Jones and Co., New York. Previous to that date, he had been president of the C. W. Hunt Construction Co., Inc. With this company, he built coal hoisting towers at the Panama Canal and Pearl Harbor. Mr. Moen was a member of several committees including the Executive Committee of the Chamber of Commerce of the State of New York. He was a past vice-president of the American Manufacturer's Export Association.

Harold Edwin Niksch (1903–1957?), superintendent of motive power and equipment, Elgin, Joliet and Eastern Railway Co., Joliet, Ill., died recently. Born, Harvey, Ill., Feb. 1, 1903. Education, BS(ME), Armour Institute of Technology, 1923. Mem. ASME, 1951. Survived by his widow.

James Wentworth Parker (1886–1957), Hon. Mem. and past-president ASME, and former president, The Detroit Edison Co., died Dec. 30, 1957. Born, Auburn, N. Y., Nov. 28, 1886. Parents, Charles A. and Sara (Cole) Parker. Education, ME, Cornell University, 1908; hon. MS, Detroit Institute of Technology, 1935; hon. DE, Stevens Institute of Technology, 1942; Polytechnic Institute of Brooklyn, 1948; Rensselaer Polytechnic Institute, 1950; University of Michigan, 1953; hon. LLD, Wayne University, 1953. Assoc-Mem. ASME, 1913; Mem. ASME, 1925; Fellow ASME, 1946; Hon. Mem. ASME, 1948. Mr. Parker joined Detroit Edison in 1910 as a boiler-room engineer, the first technically trained man to be assigned such duties in the company. He successively held positions as chief engineer of power plants, vice-president, and chief engineer, then general manager, and finally president and general manager. During his active career with the utility he organized and directed various engineering projects, including the design, construction, and operation of its power and heating plants, substations, and other buildings. His career with Detroit Edison was uninterrupted except during World War I when he was granted a leave of absence from the company and served the Nitrated Division of the Ordnance Department of the U. S. Army as a consulting mechanical engineer and head of the Division's inspection section. Mr. Parker's service to the Society had been limitless. He was manager from 1935 to 1938; a vice-president from 1938 to 1940; and in 1942, president. In the recent past he had been chairman of the ASME Research Committee on Properties of Steam. These activities among a group too numerous to list began with his appointment by the Council in 1916 to the Power Test Codes Committee, and as the first secretary of the Detroit Section. His services were not confined to ASME. He acted as chairman of the Engineers' Council for Professional Development and as such directed many important programs for that group. He was an honorary member and past-president of the Engineering Society of Detroit. He was head of that organization when the Rackham Educational Memorial was planned and constructed. In 1945, he was elected a permanent trustee of the Rackham Engineering Foundation, and was made president in 1948. He was appointed to the Atomic Energy Commission's Industry Advisory Group in 1947. During World War II he served as consultant on engineering and technical problems for the War Production Board and the War Manpower Commission. He was director of five insurance and banking firms and a vice-president of the Liberty Life and Accident Insurance Co. of Muskegon. In addition, Mr. Parker served the community as an officer or member of a great many organizations and groups. He was a member of Tau Beta Pi and Sigma Xi. Survived by his widow, Verna; a stepson, Paul Dow; a son, Breck Parker, Denver, Colo.; and a daughter, Mrs. Robert Valk, Toledo, Ohio.

Albert M. Price (1873–1957), conservator, The First National Bank of Elgin, Elgin, Ill., died Dec. 10, 1957. Born, Clarksville, Iowa, Sept. 5, 1873. Education, BS(ME), Iowa State College, 1894. Mr. Price had been a specialist in methods of manufacture and production. Assoc-Mem. ASME, 1899; Mem. ASME, 1904.

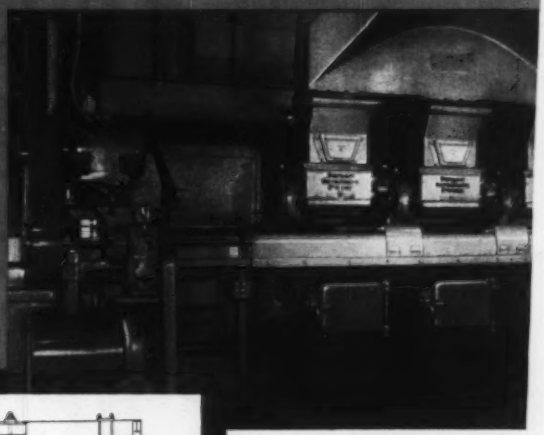
James Robinson (1904–1957?), whose death recently was made known to the Society, had been chief engineer, Vickers, Inc., Detroit, Mich. Born, Glasgow, Scotland, April 20, 1904. Education, ME, Royal Technical College, 1928. Mem. ASME, 1948. Before joining Vickers in 1930, Mr. Robinson had been with the Chrysler Corp., William Beardmore, shipbuilder, and North British Diesel Engine Works, Glasgow, Scotland.

John H. Romann (1880–1957), chairman of the board of directors, Prescott Co., Menominee, Mich., died Dec. 16, 1957. Born, Zurich, Switzerland, Nov. 22, 1880. Parents, Henry and Maria (Basshardt) Romann. Education, ME and EE, Polytechnicum, Mittweida, Germany, 1903. Naturalized U. S. citizen, Chicago, Ill., 1918. Married Johanna Roesch, 1912. Married 2nd, Evelyn Swint. Mem. ASME, 1916. Mr. Romann had been a vice-president and consulting engineer for the U. S. Engineering and Manufacturing Co., Chicago, Ill., since 1943. During the war he was chairman of the War Metallurgy Committee which conducted a special nation-wide investigation in industrial plants concerning low-temperature properties of metals. The author of several papers, Mr. Romann held a patent for Romannium used in dental work. The Governor of Kentucky, in 1934, awarded him the Kentucky Colonel citation. Mr. Romann served the Society as vice-chairman, chairman, and director of the Louisville Section. He was chairman of the War Production Advisory Committee in Louisville, and served on the Joint ASME-ASTM Research Committee.

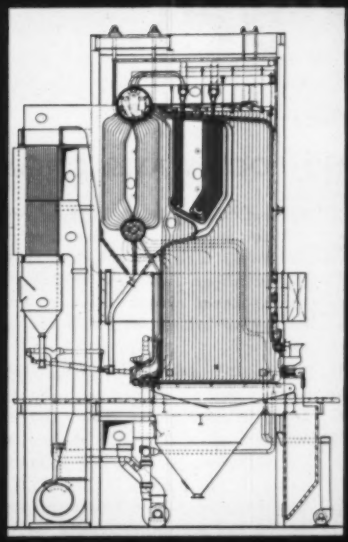
Herbert L. Watson (1883–1956), retired executive vice-president, De Laval Steam Turbine Co., Trenton, N. J., died Sept. 30, 1956. Born, Terre Haute, Ind., Aug. 19, 1883. Parents, Joseph A. and Alice L. Watson. Education, BS, Rose Polytechnic Institute, 1905. Married Nelle B. Noland, 1914. Assoc-Mem. ASME, 1907; Mem. ASME, 1921. Mr. Watson began his career with Allis-Chalmers in 1905. He joined the De Laval Steam in 1913 as general sales manager; and in 1933 he was named executive vice-president.

Mile High Plant Steam Generator Fired By DETROIT ROTOGRATE STOKER

Southern Colorado Power Co



Note —
This information is out dated.
Another Roto Grate is being added here, to fire a new 200,000# per hour unit.



This new unit which triples the capacity of the plant consists of a Babcock and Wilcox two-drum single pass steam generator fired by a Detroit RotoGrate Stoker having six feeders and distributors. The plant is at 5,300 feet above sea level. Capacity of above unit is 150,000 pounds of steam per hour at 860 psi, 915° steam temperature with preheated air at 350° F.

Design is based on bituminous coal:

B.T.U. per lb as fired	10,828
Moisture	8.84%
Volatile matter	33.72%
Fixed Carbon	44.69%
Ash	12.75%
Sulphur (separately determined)	0.7%

However, operation has been completely successful with coal from various mines in the vicinity.

Detroit RotoGrate is an exceptionally efficient spreader stoker with overlapping highly restricted grates that move slowly forward discharging ash at the front. Permits high burning rates with all Bituminous coals, Lignite or refuse fuels. *Write for Bulletin.*

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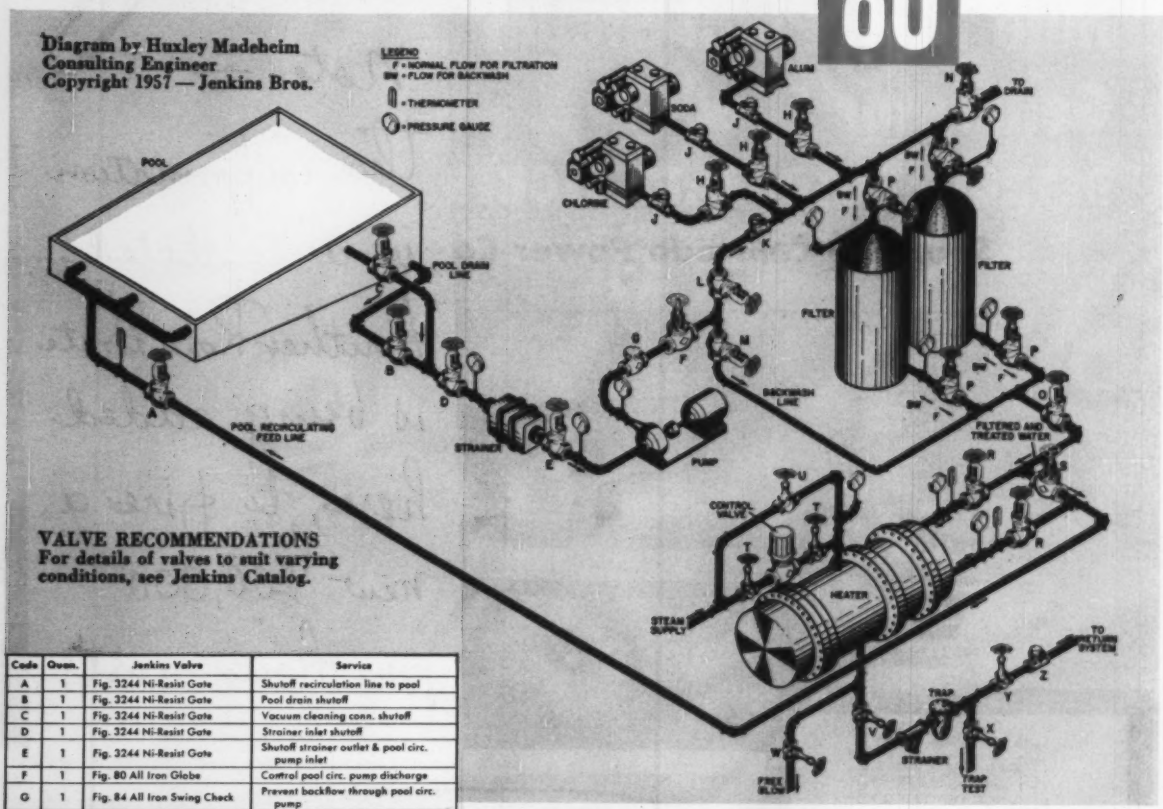

Code	Quan.	Jenkins Valve	Service
A	1	Fig. 3244 Ni-Resist Gate	Shutoff recirculation line to pool
B	1	Fig. 3244 Ni-Resist Gate	Pool drain shutoff
C	1	Fig. 3244 Ni-Resist Gate	Vacuum cleaning conn. shutoff
D	1	Fig. 3244 Ni-Resist Gate	Strainer inlet shutoff
E	1	Fig. 3244 Ni-Resist Gate	Shutoff strainer outlet & pool circ. pump inlet
F	1	Fig. 80 All Iron Globe	Control pool circ. pump discharge
G	1	Fig. 84 All Iron Swing Check	Prevent backflow through pool circ. pump
H	3	Fig. 1312 or 1313 S. S. Globe	Control chemical treatment feeders
J	3	Fig. 1328 S. S. Swing Check	Prevent backflow to chem. treatment feeders
K	1	Fig. 1328 S. S. Swing Check	Prevent backflow of chem. treatment to pump & BW line
L*	1	Fig. 3244 Ni-Resist Gate	Shutoff pool flow to filters — Normal filtration
M*	1	Fig. 3244 Ni-Resist Gate	Shutoff pool flow to filters — Backwash cycle
N*	1	Fig. 1312 or 1313 S. S. Globe	Control flow to drain
O*	1	Fig. 3244 Ni-Resist Gate	Shutoff recirc. flow to heater & pool
P	4	Fig. 1302 S. S. Gate	Shutoff filters
R	2	Fig. 3244 Ni-Resist Gate	Shutoff pool water heater
S	1	Fig. 80 All Iron Globe	Control bypass flow about pool water heater
T	2	Fig. 47-U Bronze Gate	Shutoff steam supply control valve to pool water heater
U	1	Fig. 106-A Bronze Globe	Control bypass flow st. supply pool water heater
V	1	Fig. 47-U Bronze Gate	Shutoff steam trap
W	1	Fig. 546-P S. S. and Bronze Globe	Control free flow
X	1	Fig. 546-P S. S. and Bronze Globe	Control steam trap test
Y	1	Fig. 47-U Bronze Gate	Shutoff return system from trap
Z	1	Fig. 92-A Bronze Swing Check	Prevent backflow from return system

	*Normal Cycle Filtration	*Backwash Cycle Filtration
L	OPEN	CLOSED
M	CLOSED	OPEN
N	CLOSED	OPEN
O	OPEN	CLOSED

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How to plan piping connections

FOR A SWIMMING POOL WATER CIRCUIT

In this swimming pool water circuit, water is drawn off by a pump having a strainer to remove foreign matter. Water is treated with various chemicals to render it slightly alkaline; to kill bacteria and to inhibit growth of algae and coagulated suspended solids. Water is then filtered, warmed and returned to pool through inlets. No make-up water connection is shown because most codes require an independent supply.

In normal operation of the system, valves L and O are open while M and N are closed, which permits water passage through filters and prevents flow to drain. Closing valve R and opening valve S will bypass heater when desired. Steam to heater is controlled by thermostatic valve.

Filter cleaning by "back washing" is done by closing valves L and O, and opening M and N. Water is forced through filters in reverse direction, and discharged to drain. Pool may be emptied by closing valves M and P, and opening L and N.

O. S. & Y. valves are recommended to prevent fluid action on spindle threads. All-Iron and Ni-Resist valves are specified for water circuit, and stainless steel valves where chemicals are encountered. Steam system valves are all-bronze or bronze with stainless steel trim.

Jenkins Fig. 240, and All-Iron, U-Bolt Gate, is used for shut-off control of flow to filters and heater. The solid iron wedge assures drop-tight closure, and the valve can be repacked under full pressure. Jenkins Fig. 1312 or Fig. 1313, Stainless Steel Globe Valves resist corrosion and are recommended for control of chemical and drain flow. The twin bolted bonnet and body design facilitates dismantling for cleaning and regrinding, and is especially suitable where chemicals might destroy conventional body-bonnet threading.

To assure efficiency when planning any major piping installation, consult accredited piping engineers and contractors. For prompt, capable help when you want Jenkins Valves and other supplies, call your local Jenkins Distributor. Jenkins Bros., 100 Park Ave., New York 17.

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GUIDE

Those in industry who are responsible for various phases of plant, machinery, and product design, production, operating and application engineering will find much to interest them in this NEW CATALOGS Guide. Here, reputable manufacturers, most of whom have current advertising in MECHANICAL ENGINEERING and MECHANICAL CATALOG, offer to send you without obligation, their latest literature which is described on pages 159 to 196.

FOR convenience in locating catalogs about particular equipment, product or service, a list is given below in which the numbers refer to the catalog items beginning on page 159. This will aid you in locating something specific although a perusal of the entire list may disclose other items of more than usual interest to you.

This April 1958 insertion of NEW CATALOGS Guide replaces the regular "Keep Informed" Section for this issue. The "Keep Informed" Section will appear regularly again beginning with the next issue.

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Read the various items listed... one catalog may hold the solution to your present problem...

1 SPHERICAL ROLLER BEARINGS

SKF Industries—Bulletin No. 443-A discusses the company's improved (Type C) spherical roller bearing which is said to increase capacity 25 to 50 per cent and service life 2 to 3½ times. All bearings having a 140 mm or larger outside diameter also have a new lubricating feature in which the lubricant is channeled directly to the center of the bearing, completely covering all working surfaces. The booklet also lists several series of pillow blocks which are furnished with "C" type bearings, and a new line of "Take-Up" units.

2 PNEUMATIC TRANSMITTERS

Mason-Neilan Div., Worthington Corp.—Bulletin No. 214 describes pneumatic transmitters for temperature and pressure applications in process control. Transmitters may be installed in any position without zero shift. Complete specifications and operational diagrams are included.

3 DIESEL SYNCHRONOUS GENERATORS

Marathon Electric Mfg. Corp.—Ten-insert loose-leaf Bulletin No. SB-184 features 320, 400, 500 and 580 frame synchronous generators from 30 to 300 kw at 1800 rpm for use with diesel engines. Pages show generator, wall mounted control cabinets, connection diagrams for selecting voltages from 120 v to 480 v, generator, control interconnections, package control model chart, 340 service stations servicing motors and generators.

4 SEAMLESS WELDING FITTINGS

Babcock & Wilcox Co., Tubular Products Div.—Welding Fittings Dept. Bulletin FB 77 covers computing preliminary design requirements of pressure piping systems. The bulletin summarizes and correlates various specifications of the ASTM and ASA.

5 HEAVY DUTY PUMPS

Kobe Inc.—Bulletin 1157 covers Triplex pumps for heavy duty service as high pressure sources of hydraulic power. The units are plunger type, for applications up to 20,000 psi, 58 gpm. Features include vertical design, automotive type crankcase, spring-loaded ball type valves with replaceable seats, and pump for pressure and splash lubrication.

6 VERTICAL FOUR-SLIDE MACHINE

Torrington Mfg. Co.—Bulletin V-82 details operating features, specifications for new Verti-Slide all-purpose vertical four-slide machine. Design details and component functions are given for feed mechanism, cam and cam shafts, drive system, and presses. Photos illustrate operation of slides, slide bases, center former, lubrication system, and clutch.

7 CONVEYOR BELTING

Manhattan Rubber Div., Raybestos-Manhattan, Inc.—Catalog 25CB illustrates and describes conveyor and elevation belts. It covers new style designations of general service heavy duty types made with special strength numbers. Tension ratings, minimum pulley diameters and minimum belt widths are given.

8 VIBRATION TEST EQUIPMENT

MB Mfg. Co.—Eight-page bulletin describes complete complex motion and sine wave vibration generating systems for research and development or production test. Included is technical information with illustrations on vibration exciter, amplifier, control console, and compensation console, references for detail specifications, blueprints, and performance charts.

9 GEAR REDUCERS

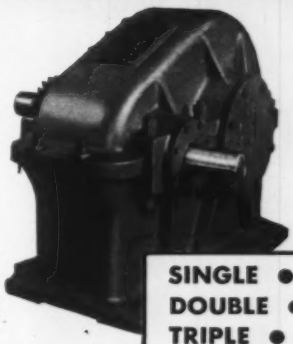
Lovejoy Flexible Coupling Co.—Form R-58 illustrates and describes 18 models of shaft mounted gear reducers in speeds of 8 to 425 rpm, fractional to 120 hp, ratios of single 4.5:1 nominal and double 14.7:1 nominal, and with hollow shafts of 1⁷/₁₆ to 5 ¹⁵/₁₆ in.

10 DRAWING TAPE PEN

Chart-Pak, Inc.—Literature covers the firm's new Tape-Pen, a metal holder-dispenser for tapes used in the preparation of master drawings. The pen is available in sizes to fit ¹/₈, ¹/₁₆, and ¹/₃₂ in. tape.

Continuous Tooth

HERRINGBONE GEAR SPEED REDUCER



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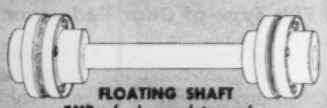
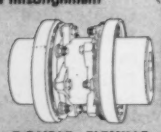
DBZ — for high speed, heavy duty drives

Thomas' 40 years of flexible coupling experience is at your disposal to help you meet ordinary applications or special variations for unusual cases.



FLOATING SHAFT
BMR — for heavy duty service with excessive misalignment

SINGLE FLEXING
SS — for engine-driven generator sets with out-board bearings



DOUBLE FLEXING
AMR — for engine and medium speed drives

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES.

1 Freedom from Backlash Torsional Rigidity
2 Free End Float
3 Smooth Continuous Drive with Constant Rotational Velocity
4 Visual Inspection While in Operation
5 Original Balance for Life
6 No Lubrication
7 No Wearing Parts
8 No Maintenance

Write for Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U. S. A.

YOUR *New Catalogs* GUIDE

LATEST INDUSTRIAL LITERATURE

11 REPRODUCTION MATERIALS

Eastman Kodak Co.—All materials available for reproduction of drawings and documents described in a booklet. A selection chart which matches originals to be reproduced with the recommended materials is included.

12 REFRACTORIES

Carborundum Co.—Bi-monthly bulletins about refractories, their properties, uses and recent developments, are available. Subjects covered include muffled constructions, brickwork construction, research and development, a new silicon carbide refractory, wear resistance refractories, hot strength, heat resistance of refractories, thermal-shock resistance, chemical resistance, and stability.

13 HIGH TEMPERATURE PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 128 illustrates Types A, AC, OV, UNI, multistage, centrifugal pumps for high pressure, high temperature heavy duty services. The pumps range in size from 2 to 8 in. with maximum speeds to 6000 rpm, capacities to 2700 gpm, maximum temperatures to 850 F, discharge pressures to 2000 psig, and differential heads to 4500 ft.

14 SELF-ALIGNING COUPLINGS

Koppers Co., Metal Products Div.—A 16-page brochure describes principles and features of Fast's self-aligning couplings, illustrates and describes each available standard and special model.

15 WORM GEAR REDUCERS

Jones Machinery Div., Hewitt-Robins, Inc.—A 40-page booklet contains description of various worm gear reducer designs with horsepower ranging from less than .1 to 121. Numerous drawings and specification tables show designs and ratings for standard units available.

16 ALLOY STEELS

Copperweld Steel Co.—A 16-page bulletin covers lead treated steels. Case histories of components made of the material are included, along with data on characteristics and mechanical properties of various leaded alloys.

17 FIXED TYPE GAGES

Sheffield Corp. —Catalog LTG-54, 148 pages, is composed of six sections covering the company's standard fixed type gages. A complete engineering manual for gage designers and users is included in the catalog.

18 WELL WATER SYSTEMS

Layne & Bowler, Inc.—Bulletin 100 contains case histories and application photos of well water systems, pumps, shutter screens, special drilling applications featuring vertical turbine pumps.

19 O-RINGS

National Seal Div., Federal-Mogul-Bower Bearings, Inc.—This National O-ring Catalog is designed for broadest usefulness in all types of O-ring applications. Includes practical working information about O-ring applications, sizes, groove dimensions, back-up rings, and dust seals, and lists all National O-rings and local National Seal Division offices.

20 DUPLICATING BALL POINT PEN

Venus Pen & Pencil Corp.—Sample Thermocopy ball point pen is offered to demonstrate its design to give clear, legible reproductions in duplicating processes. The firm says newly formulated super-opaque ink allows sharp markings on original copies or masters. It is available in black, red, green or blue nonsmear ink, and may be used for Thermofax, Bruning, Diazo, Verifax, and offset processes.

21 FINNED-TUBE HEAT EXCHANGERS

Alco Products, Inc.—Bulletin describes longitudinally finned tube heat exchangers said to offer unequalled heat-transfer characteristics provided by metal-to-metal fusing between U-shaped fin channels and tube. Publication includes mechanical specifications and charts showing finside coefficient and finside pressure drop.

22 FLEXIBLE CUSHION COUPLING

Dodge Mfg. Corp.—Bulletin A-669, 12-pages, contains general information, photographs, and engineering drawings on a rubber tire coupling designed to accommodate angular misalignment, parallel misalignment and end float, singly or in any combination, and cushion shock leads and absorb torsional vibration. Tables with engineering data to facilitate selection of couplings for many applications are included.

23 CONVEYOR-ELEVATORS

Stephens-Adamson Mfg. Co.—Catalog 358 illustrates the firm's line of conveyors, elevators. Typical arrangements are diagrammed; power requirements, specifications and installation data is given. Applications in various industries are illustrated and described.

24 MINIATURE MECHANICAL CHAIN

Sierra Engineering Co.—Catalog describes miniature mechanical chain and sprockets, gives engineering data on chain which operates smoothly around a 7-tooth sprocket with a root diameter of .250 in. and has a pitch of .1475 in. The unit is for use where precise motion control is needed in miniature assemblies, especially where motion is to be transferred through several planes simultaneously.

25 ALLOY STEEL PIPE

U. S. Pipe & Fdry. Co., Steel & Tubes Div.—Bulletin illustrates and describes turned and bored, metal mold, centrifugally cast alloy steel pipe. Case histories are given, along with a description of the manufacturing process.

26 DIAPHRAGM VALVES

Grinnell Co.—An 8-page catalog describes diaphragm valves offering streamlined fluid passage, flow control, leak-tight closure. Isolation of working parts from fluid stream is said to prevent product contamination and corrosion of operating mechanism. Flexibility of assembly and wide choice of materials for bodies, body linings and diaphragms are described.

27 HEATING, AIR CONDITIONING

Surface Combustion Corp.—A 28-page brochure describes equipment engineered and built by Surface Pelletizing, Steel Mill, Heat Treat, Glass, Webster Engineering Co.—Boiler Burner, Kathabar Air Conditioning and Drying, Janitrol Aircraft and Janitrol Heating, and Air Conditioning divisions.

28 AIR, HYDRAULIC CYLINDERS

Anker-Holth Div., Wellman Engineering Co.—Brochure AD-3 describes and illustrates standard air and hydraulic cylinders and valves, including five types of air cylinders, four types of hydraulic cylinders, also rotating air and hydraulic cylinders.

29 BOILERS, STOKERS

James Leffel & Co.—Information on Scotch boilers for gas, oil and coal firing and automatic under-feed stokers is given in a 28-page bulletin, No. 236. The brochure includes test results, performance data, and details of design and construction.

On the Job When it Counts

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

30 SWIVEL JOINTS

Continental-Emsco Co.—Swivel joint catalog covers joints for use throughout the petroleum, chemical and general industry. Swivelettes are designed to provide flexibility on gasoline pump hoses, machine tool coolant lines, paint sprayers, liquid and air handling equipment at a very low, cost allowing replacement rather than repair.

31 ROLLER BEARINGS

Hyatt Bearings Div., General Motors Corp.—Catalog 150 illustrates and describes solid roller bearings, wound roller solid race and split race bearings, industrial inch bearings and solid roller bearings in separable inner race, separable outer race and nonseparable types.

32 SPUN STEEL TUBING

American Cast Iron Pipe Co.—Illustrated 64-page catalog describes special products division facilities, the centrifugal spinning process, its advantages and illustrates versatility of application of tubes. It contains tables, technical data, engineering information for stainless and carbon steel tubes 2.25-50 in. OD.

33 FORGINGS

Kropp Forge Co.—A 40-page booklet illustrates and describes the firm's facilities and services for producing forgings of steel, titanium and alloys. Data is given on practices and tolerances for impression die forgings, drop forgings, flat die forgings, die sinking and machining.

34 BUSHINGS, BEARINGS

American Crucible Products Co.—A 12-page bulletin covers bushings, bearings, bar stock, and babbitt metal made of the firm's Promet bronze. In addition to technical data and case histories, material is included on the company's laboratory and plant facilities.

35 VALVE OPERATORS

Ledeen Mfg. Co.—Bulletins illustrate and describe company's line of pneumatically or hydraulically operated valve operators for direct or remote control of gate, diaphragm and plug valves. Selection information, torque ratings, dimensions, and weights are given.

36 CERAMIC INSULATED WIRE

Aero Research Instrument Co.—Descriptive bulletin describes ceramic insulated wire, used for reactor thermocouple wire and leads, power leads, low-level instrument signals, and resistance elements, in high radiation fields, at high pressure, and temperatures 400 to 2000 F. Wire is available in several sheath diameters from 0.025 to 0.31 in., multiple conductors, and a variety of sheath and conductor materials.

37 PRESSURE GAGES

American Chain & Cable Co., Helicoid Gage Div.—The 24-page Helicoid gage catalog describes the Helicoid gage as guaranteed accurate to within $\frac{1}{2}$ of 1 per cent of the total dial graduation over the upper 95 per cent of the 270-deg dial arc. Cutaway photographs and line drawings show the complete line of Helicoid gages.

38 BOILERS, ACCESSORIES

Bituminous Coal Institute—Specifications for typical low-pressure commercial heating plant are given in Bulletin AIA-30-A. Heating plant operates at 20,000 equivalent direct radiation or 4,800,000 Btu/hr and is adaptable to design loads of 3000 to 24,000 edr or 750,000 to 5,500,000 Btu/hr.

39 MOTION PICTURE CAMERAS

Wollensak Optical Co.—A catalog explaining high-speed photography, its application and the results obtainable and a folder describing the operation and uses of the Fastax high-speed motion picture-oscillographic camera are available. These cameras, used in research, design, commercial engineering, are a continuous moving film type with rotating prism positioned between the lens and the sprocket. They are available in 8, 16 and 35 mm in both 100 and 400 ft capacity.

40 GAS TURBINE ENGINES

Solar Aircraft Co.—New 24-page brochure describes the company's 500 hp Jupiter gas turbine engines. The brochure contains photos of installations, cutaway views of different engine configurations, performance charts, outline drawings. Sections describe comparative performance of gas turbine and diesel engines, principles of gas turbine power, components and accessories, and potential applications.

41 EXPANSION JOINTS, PIPING DESIGN

Marquette Copperasmithing Co.—Semi-technical, short report covers service history, test results, manufacturing procedures related to Omega expansion joints and their application to power and process piping systems.

42 STEAM TURBINES

Terry Steam Turbine Co.—Bulletins in looseleaf form which cover a complete description of Terry solid wheel turbines with cross section drawings of typical units for both moderate and high steam pressure conditions: a description of the Terry axial flow impulse, both single stage and multistage; Terry gears which are used for speed increasing and speed reducing.

43 UNDERGROUND PIPE INSULATION

Zonolite Co., Z-Crete Div.—A 12-page brochure gives data, drawings, typical installations on Z-Crete, a monolithic, cast-in-place underground insulation.

44 ROTARY ELECTRICAL UNITS

Western Gear Corp., Electric Products Div.—Bulletin 5721 contains specifications and diagrams of the firms permanent magnet and wound field d-c motors, a-c motors with and without gear reduction, a-c/d-c generators, motor and fan assemblies, axial flow blower assemblies, centrifugal blower assemblies and voltage regulated power supplies and stroboscopes.

45 PLASTIC RESINS

E. I. duPont de Nemours & Co.—Catalog A-4813 illustrates and describes characteristics, forming and working techniques and end-use applications of Teflon tetrafluorethylene resins, Zytel nylon resin, Alathon polyethylene resins and Lucite acrylic resin. Detailed properties charts are listed.

46 HYDRAULIC MACHINERY

Watson-Stillman Press Div., Farrel-Birmingham Co.—A 24-page bulletin gives information on injection, compression, and transfer molding machines for the plastics industry; extrusion presses for ferrous and nonferrous metals; metalworking equipment; railroad shop equipment; ordnance equipment; standard and special machinery for general industrial applications.

47 FOUR-CYCLE ENGINE

Nordberg Mfg. Co.—Nordberg four-cycle diesel, Duafuel and spark ignition gas engines, ranging from 640 to 2150 hp are described in Bulletin 257. The in-line engines are built with either six or eight cyclinders as supercharged; supercharged and intercooled; and Supairthermal units. Design features, dimension drawings and installation photographs are included in 16-page brochure.

48 STRUCTURAL PANEL

Philip Carey Mfg. Co.—A folder, Form No. 6293 describes a 2-in-1 insulated structural panel for interior use in duct construction, industrial ovens, coil housings, plenum chambers. It is formed of laminated plies of corrugated and flat asbestos paper sheets, bonded with a fire-resistant adhesive suitable for continuous temperature up to 1000 F.

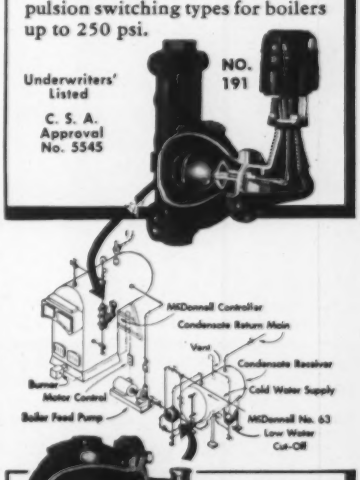
49 NEW COMPLETE PLUG GUIDE

Cannon Electric Co.—A complete 40-page plug guide describes the lines of various electrical connectors and their uses. The different connector lines or groups are shown with brief descriptions, along with the proper catalog to request for complete information pertaining to each line.

McDonnell Answer
... for boilers up to 150 psi

McDONNELL No. 191
Water Column Type Pump Control
Cut-off and Alarm Switch

Controls the boiler feed pump the one right way—from the boiler water level itself. Introduces new repulsion magnetic switching for positive opening *and* closing. Quality is attested by its use as standard equipment on many fine "package" boilers. Other repulsion switching types for boilers up to 250 psi.



McDONNELL No. 27T MAKE-UP WATER FEEDER

Automatically adds water to condensate receiver to make-up for any defficiency in returns. Has large feeding capacity to meet any sudden boiler demand. Stainless steel needle and seat assure drip-tight closing. For tank pressures to 35 psi., supply pressures to 100 psi.

Write for Bulletin L-123

McDONNELL & MILLER, Inc.
3510 Spaulding Ave., Chicago 18, Illinois

Doing One Thing Well

McDONNELL
Boiler Water Level Controls and Safety Devices

CHACE

THERMOSTATIC BIMETAL
ACTUATES ANOTHER
PRECISION PRODUCT

I-T-E

"CORDON"
CIRCUIT
BREAKER

A Product of
I-T-E Circuit Breaker Co.
Philadelphia, Pa.

The I-T-E "Cordon"® Circuit Breaker is designed to safeguard low-voltage distribution circuits against fault currents up to 100,000 rms. amperes. Through the coordination of thermal-magnetic, and current-limiting action, protection is provided against momentary overloads as well as low or high magnitude fault currents. In one compact, easily installed, easily serviced unit, "Cordon" supplies an economical solution to ever-increasing interrupting requirements.

I-T-E's high quality-standards for its "Cordon" Circuit Breaker are met by Chace Thermostatic Bimetal, a product of over a third of a century of specialization. Precision-rolled by Chace to the closest tolerances, Chace Bimetal qualifies for the job only after a relentless series of tests and inspection procedures. Chace Thermostatic Bimetal is manufactured by a series of exclusive processes which create a product acclaimed for its performance, assurance that each unit will perform its equipment-safeguarding role with instantaneous, automatic, and unfailing action at all times. It is for reasons such as these that Chace Thermostatic Bimetal is specified for actuating the widely-used, high-quality I-T-E-"Cordon" Circuit Breaker.

Remember Chace when you design for protection of valuable equipment or for temperature actuation or indication. Dependable Chace Thermostatic Bimetal is available in over 30 types, in strip, coil or completely fabricated and assembled elements made to your specification. (We do not manufacture complete controls or any other devices in competition with our customers). Write today for *new* 1958 booklet, "Successful Applications of Chace Thermostatic Bimetal," containing interesting uses of bimetal and many pages of engineering data that may help you solve your design problems.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

YOUR *New Catalogs* GUIDE

50 STORAGE WATER HEATERS

Patterson-Kelley Co.—A 48-page catalog includes 1956 ASME Code for unfired pressure vessels, features standard carbon steel, copper-lined, copper-silicon, cement-lined and galvanized storage water heaters for commercial and industrial use. Selection tables of capacities, weights, dimensions, hot water fixture capacities, material thicknesses, heating elements, and piping diagrams are included.

51 PACKINGS

Johns-Manville—A 12-page brochure, PK-17A, contains a packings selection chart of rod, plunger, and valve stem packings; illustrations and descriptions of precision rings, hydraulic and groove packings, oil seals, metallic and cut gaskets. Friction materials are also described.

52 HYDRAULIC CYLINDERS

Oilgear Co.—Bulletin 71000 covers 2000 psi double-acting hydraulic cylinders. Foot lug, center lug, front flange, rear flange, and clevis mounting cylinders are described.

53 HYDRAULIC HOSE FITTINGS

Parker Fittings & Hose Div., Parker-Hannifin Corp.—Catalog 4440 describes reusable Hoze-lok fittings and rubber covered wire braided hose for medium pressure service. Fittings are no-skive type, so cover of hose is not stripped off when assembling the fittings. Inside diameters range from $^{3}/_{16}$ through $1\text{-}^{1}/_{4}$ in.

54 AXIAL, MIXED FLOW PUMPS

C. H. Wheeler Mfg. Co., Economy Pump Div.—Horizontal and vertical axial and mixed flow pumps are described in a 12-page bulletin. Pumps are recommended for condenser circulation, primary water supply, drainage, irrigation, flood control and other applications which require large volumes of liquids containing small solids at low to medium heads.

55 ULTRASONIC TESTER

Sperry Products, Inc.—An eight-page bulletin covers applications of the ultrasonic Reflectoscope for nondestructive testing of products and equipment. It explains in simplified terms the principle of ultrasonic inspection and lists the latest types of equipment available.

56 AIR DIRECTIONAL VALVES

Westinghouse Air Brake Co., Industrial Products Div.—An eight-page catalog describes two-, three-, and four-way spool type directional valves with solenoid, lever, push button, pilot cylinder, cam, treadle and pedal operators. Valves have tapped exhaust or open exhaust. In neutral, spools close all passages, connect delivery passages to exhaust or connect delivery passages to supply.

57 ROLLER CHAINS, SPROCKETS

Diamond Chain Co., Inc.—Catalog 757 covers the firm's line of stock roller chains and sprockets. Data on selection, establishing service horsepower and determining size of driven sprocket is included.

58 UNDERGROUND PIPE INSULATION

American Gilsonite Co.—A four-page Bulletin gives tips on the uses and installation of new insulation for hot underground pipes. It explains how the material protects pipes against corrosion caused by acids and alkaline ground waters, and against bacterial action, roots and electrolysis.

59 INDUSTRIAL COOLING FANS

Koppers Company, Inc., Metal Products Div.—A 4-page folder illustrates and describes new, all-metal, "Precision-Engineered" Aeromaster fans for cooling towers and radiator-type coolers. Design features are discussed.

60 TESTING DEVICES

Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div.—Bulletin 4300 lists SR-4 devices and equipment for load, torque and fluid pressure measurement and control. Numerous application photos in all fields are included in this 20-page bulletin.

YOUR *New Catalogs* GUIDE

61 DYNAMOMETER BASES

Lake Shore Engineering Co.—Catalog D455 describes dynamometer bases, base plates, surface plates, engine jacks, and stands. Booklet contains outline drawings of standard plates, photos of automotive plant installations and smaller shop applications.

62 HIGH-STRENGTH STEELS

United States Steel Corp.—A 174-page manual discusses the essential principles of structural design and contains numerous formulas, charts and tables to assist in designing, for high-strength steels. The book covers engineering considerations and fundamental characteristics of high-strength steels, design considerations, working unit stresses, tension, compression, shear, stresses in beams, deformation and deflection, formed sections and designing against corrosion.

63 OIL-RETAINING BEARINGS

Bound Brook Oil-Less Bearing Co.—More than 600 of the most widely used sizes of oil-retaining porous bronze bearings are listed in the firm's Stock List No. 4. Also provided is condensed information on application, installation, lubrication and machining.

64 POWER TRANSMISSION PRODUCTS

Boston Gear Works—A 576-page, pocket-sized catalog contains information on 7,124 standardized power transmission products. More than 50 pages of engineering data are included.

65 METAL GASKETS

Chicago-Wilcox Mfg. Co.—Form 569 illustrates and describes corrugated metal, asbestos-cord-filled, and plain solid self-sealing gaskets. Drawings show installation procedures.

66 INDUSTRIAL WIRED TELEVISION

Diamond Power Specialty Corp.—Bulletin 2140 describes Model 500 Closed Circuit Television Camera System. . .compact and complete for industrial use. Picture of gages, instruments, conveyors, remote gates, furnaces etc. viewed on cable connected standard TV receiver or UtiliVue Monitor. Camera is self adjusting to compensate for wide variations in scene brightness. Weatherproof housings available for outdoor use.

67 INSPECTION INDICATING GAGES

O-Vee Gauge Co.—Bulletin illustrates and describes new line of heavy rugged indicator gages with lever type amplification which provides greater reliability. Provision is made to enable gaging fixtures and stages to be made at low cost. Examples are illustrated in the bulletin.

68 LUBRICANT DATA

Fiske Bros. Refining Co., Lubriplate Div.—1958 edition of The Lubriplate Data Book to all who are interested in subject of proper lubrication of all types of machinery. This new Data Book is 8½ × 11 in. in size and contains 36 pages of valuable data pertaining to improvement of machine operation, reduction of power consumption and lowest possible maintenance costs through the use of specialized time tested lubricants.

69 THREAD INSERTS

Heli-Coil Corp.—Catalog on standard line of screw thread inserts designed for protection and repair of tapped threads in all materials is contained in Bulletin 652-A. Covered are design information, drilling and tapping recommendations, and specifications for various classes of fit. Also available is Bulletin 738 which provides similar details on new screw-lock insert which eliminates the need for lock washers, lock nuts, lock wiring.

70 CLUTCHES, BRAKES

Autotronics, Inc.—Catalog 957 illustrates and describes sub-miniature electro-magnetic clutches and brakes. Engineering and dimensional data, diagrams, and performance curves are given for ten models and combinations.

71 MATERIALS HANDLING

Syntron Co.—A condensed catalog, No. 5712, contains 50 pages of technical data, brief description and photographs of bin vibrators, vibratory feeders, vibratory conveyors, power tools, shaft seals, selenium rectifiers, vibrating parts feeders, heating elements and other equipment.

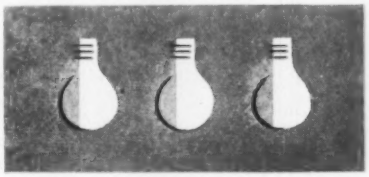
HYDRO-FILTER

Hydro-Filter Highlights of:
DUST CONTROL DOINGS

Dust Control problem of light bulb manufacturer is brought to light

The Problem:

A leading manufacturer of light bulbs wanted to build a new manufacturing line but was plagued by problems they had experienced with an existing wet scrubber. *No wonder . . .* powdered glass, broken bulbs, colored ceramic frit, alcohol and resins are used in the process and the line must operate 24 hours a day—7 days a week. A shutdown on the dust collector would mean a shutdown for the entire operation because of dust and noxious fumes. As a result, only two scrubber manufacturers would bid on the job.



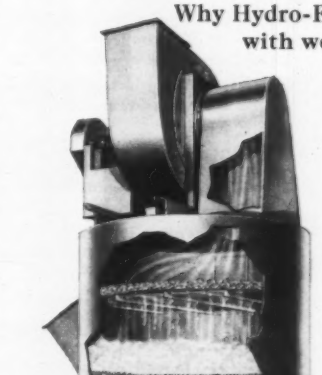
The Solution:

A type I Hydro-Filter with automatic sludge conveyor was selected for the job after customer evaluated evidence of its efficiency on the basis of (1) ability to operate at rated efficiency over prolonged periods at heavy dust load; (2) ability to operate over prolonged periods without shutdown for maintenance.

The Result:

Hydro-Filter did the job, and more. After 6 months operation the company ordered their *second* Hydro-Filter.

Why Hydro-Filter combines exceptional efficiency with welcome ease of maintenance:



Can be equipped with automatic sludge conveyor or furnished with cone bottom.

Units available from 250 to 40,000 CFM capacity

Air, water and glass spheres do the work in Hydro-Filter. There are no moving parts in the collection area. No baffles; nothing to load up and no "dead" areas to make cleaning a chore and efficiency a *myth*. The relatively simple design permits economical use of special materials of construction. It is designed to operate on dusts, sprays, fumes, and mists and can be equipped for recirculation of the liquid scrubbing medium.

Hydro-Filter will maintain a constant high level of efficiency over wide variations in volume of air and heavy dust loads. And because of its simple design, it will provide ease of maintenance *unmatched by any equipment* for similar use.

Write for descriptive bulletin today.

TIRED OF DUST COLLECTOR MAINTENANCE?
. YOU'RE READY FOR HYDRO-FILTER

HYDRO-FILTER

National Dust Collector Corporation

600 Machinery Hall Building • Chicago 6, Illinois

YOUR *New Catalogs* GUIDE

72 CHECK, RELIEF VALVES

Circle Seal Products Co.—Leakproof precision check, relief, shutoff, and shuttle valves are described in a new brochure which also explains how the valves work, shows available sizes and dimensions, includes service recommendations, and indicates information desirable to allow the best valve for your application to be specified.

73 CONDENSATE DRAINAGE CONTROL

Cochrane Corp.—Bulletin 6025A illustrates and describes the firm's system for returning condensate to boilers at high pressure and temperature. Technical data on standard and high differential units and installations in various industries is included.

74 CONDENSER TUBES

American Brass Co.—A 44-page manual on selection of condenser tube and tube sheet materials discusses the application and installation of copper and copper alloy condenser and heat exchanger tubes, plates for tube sheets, heads and baffles. Included is a review of corrosion factors in condenser tube service.

75 HONING EQUIPMENT

Micromatic Hone Corp.—A 32-page catalog, AR-136, explains Microhoning process, including stock removal and automatic size control. Applications, specifications, work capacities of machines for small, medium range diameters, long stroke vertical machines, horizontal machines, multiple-spindle machines are given. Also described are tools, job services, and other company aids.

76 TOOL STEELS

Crucible Steel Co. of America—Forty-six pages of information concerning tool steels for forging operation, the die casting process and the hot extrusion process. A series of charts detail the tool steel and heat treatments recommended for numerous forging, die casting, and extrusion operations. Also included is a brief trouble shooting guide.

77 GEAR REDUCERS, INCREASERS

Lufkin Foundry & Machine Co.—Catalog G-4 covers engineering and dimensional data on standard lines of slow and medium speed herringbone gear reducers of single and double reduction type and high speed herringbone gear units for speed reducing or speed increasing service. Engineering data on selection of size is given.

78 AUDITORIUM AIR CONDITIONERS

John J. Nesbitt, Inc.—Catalog 22 illustrates and describes AudiCon air conditioner, designed especially for school auditoriums and other large assembly areas where quietness is important. Unit features silencer discharge plenum, plus return air bypass control.

79 DIAPHRAGM SEALS

Bellofram Corp.—A 16-page catalog gives basic product descriptions, applications, and operation data on diaphragm seals. Installation information, size tables, and available materials data are included.

80 PACKAGED BOILER

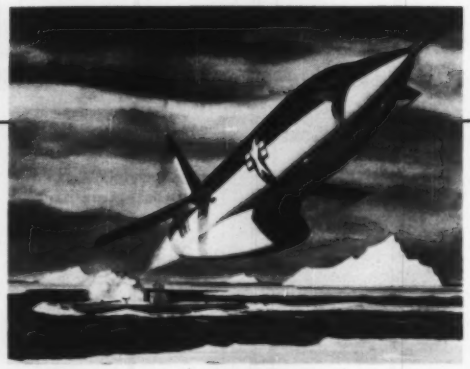
Cleaver-Brooks Co.—Literature describes the firm's new Monitor packaged boiler for dairies, laundries, and bottling plants. The unit is automatic and is said to eliminate the need for an expensive chimney.

81 TORSIONAL VIBRATION DAMPER

Houdaille Industries, Inc., Buffalo Hydraulics Div.—A brochure describes the operation and use of viscous torsional vibration dampers. It includes a data sheet required to apply this damper to internal combustion engines and rotary systems likely to have critical speeds in the operating range. The damper is untuned and said to provide highly efficient damping even when damper is not optimum for the system.

82 PRESSURE REGULATORS

Spence Engineering Co.—New four-page brochure, No. 1011 covers pressure regulators. Selection data and photos are presented on three principal types of main valves and pilots. Line drawings show three suggested applications of regulators. A steam capacity table for the selection of main valve size is included.



Key Openings in Product Design

VOUGHT'S supersonic piloted and pilotless weapon systems provide the Design Engineer with the opportunity to travel the complete cycle of engineering. The separated missile and manned aircraft design organizations are working in extremely refined areas on a number of advanced weapons. Here, the designer's responsibilities include detail design, analysis and installation studies. He writes test requirements and procurement specs. Following are key positions in which creative designers may develop rapidly into well-rounded, systems-conscious candidates for top-level posts in missile or aircraft projects.

Senior Missile Airframe Designer. To develop, design and test missile structural members, including control surfaces and linkages. Requires A.E., M.E., C.E. or Arch. E. with at least 3 years mechanical structural design experience.

Cockpit Designer and Stylist. To specialize in functional, attractive cockpit design. Requires 2 years experience in industrial styling plus 2 years practical design experience and strong creative ability.

Power Plant Installation Designer (Missiles). To design fuel, air induction and accessory systems, and engine mountings. Requires A.E. or M.E. plus experience in preparing specifications and layouts.

Armament Design Engineer (Aircraft). To design, install and test gun, rocket and missile systems. Requires A.E. or M.E. and either one year armament installation design experience, or 3 years general design experience.

Senior Hydraulics Engineer (Aircraft). For development, detail design and test work on complex hydraulic power control systems. A.E. or M.E. and at least 4 years experience in hydraulic design.

Senior Design Liaison Engineer (Missiles and Aircraft). To join and eventually head a liaison team investigating manufacturing problems arising from design. Requires degree, or equivalent, plus 3 years general design experience and good knowledge of shop loading, fabrication, quality control and material selection procedures.

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City _____ State _____

Vought Vocabulary

in′ge·nu′i·ty: *designing a 12-ton missile to fit inside an atomic sub*

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They shock-proofed the missile against underwater blasts. They conditioned it for polar ice, or equatorial heat. They made it — like Vought's smaller Fleet veteran, *Regulus I* — a dependable weapon, accurate from conventional or nuclear subs, from surface ships or highly maneuverable, mobile shore launchers.

Aboard its special, globe-girdling sub, *Regulus II* will move *invisibly* any distance to its launching point. There it can begin a supersonic, long-range strike in minutes. Or it may lurk unseen for months as a patient and ready deterrent.

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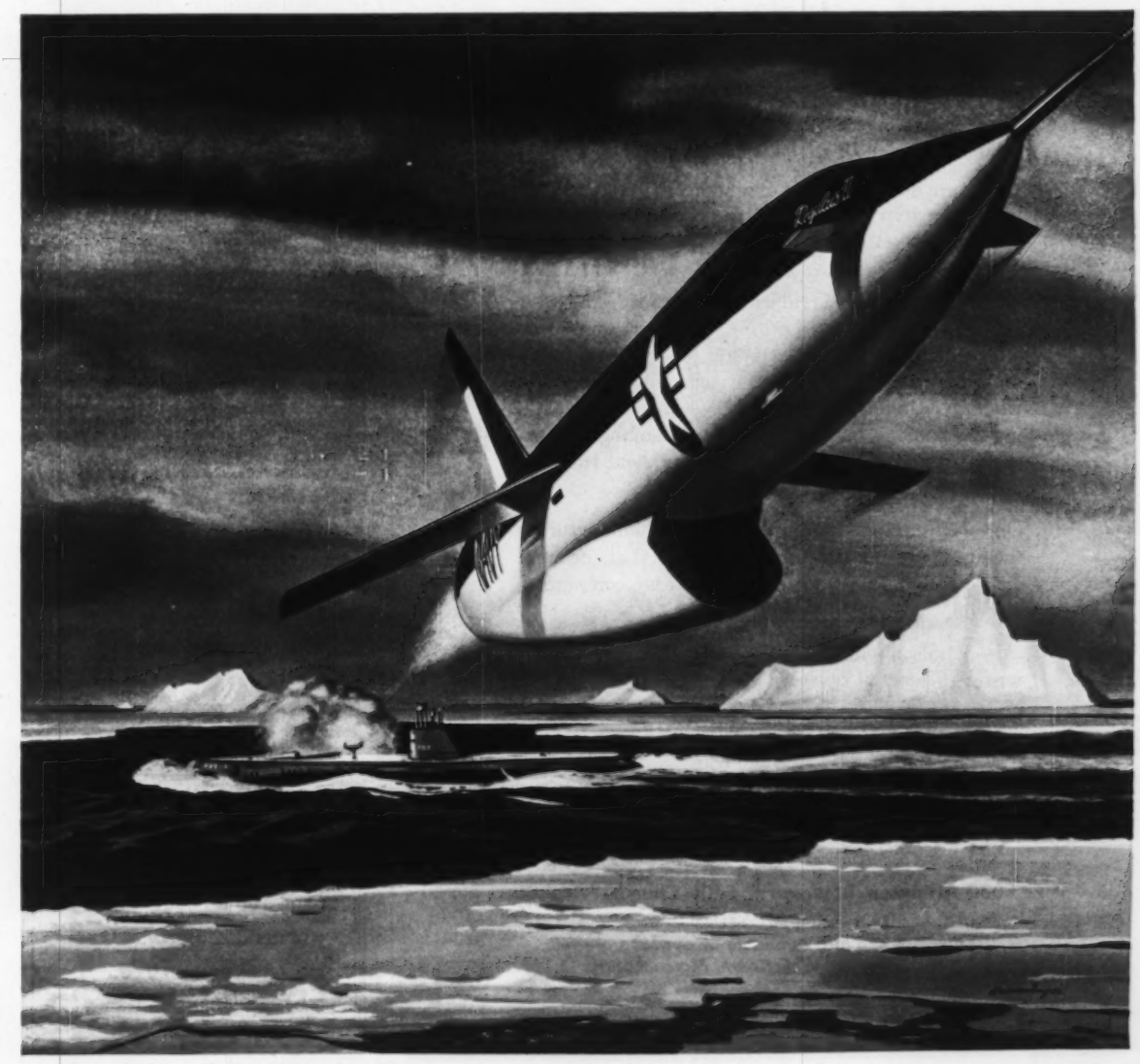

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YOUR *New Catalogs* GUIDE

83 STEAM GENERATORS

Foster Wheeler Corp.—Bulletin B-56-5 gives drawings and technical data on steam generators in 60 installations. Also included is data on accessory equipment, reheaters, and superheaters.

84 PNEUMATIC INSTRUMENTS

Republic Flow Meters Co.—Six specification folios cover null-balance-vector pneumatic instruments for utility and process control systems. Described are controller, pressure transmitter, differential pressure transmitter, temperature transmitter, and ratio relays.

85 ELECTRIC HEATERS

Edwin L. Wiegand Co.—Catalog D-52 illustrates and describes electric blower-type portable unit heaters, wall and ceiling mounted unit heaters, forced air heaters for large areas, radiant and convection comfort heaters, thermostats and contactors for commercial and industrial use.

86 BALL BEARING SWIVEL JOINTS

Chiksan Co.—A revised 32-page catalog, G-4R covers the company's line of ball-bearing swivel joints, loading racks, manifolding lines, all-metal marine and barge hose, and flexible aircraft assemblies. Typical industrial applications are illustrated and dimensional and operating data is provided.

87 GASKETS METAL RASCHIG RINGS

Metallo Gasket Co.—Bulletin No. 57 describes metal and metal combined with soft packing for use on high and low pressure service, metal tower packing made as Raschig and Lessig rings. Also included are washers, shims, and metal asbestos valve disks.

88 DUCTILE IRON

International Nickel Co.—Ductile Iron Digest describes new cast metal with up to 200,000 psi tensile strength that can be twisted and bent without cracking. Charpy impact ranges from 15 to 115. Case records show how strength and toughness can be cast in tiny levers and huge engine frames.

89 NEW METHOD OF LUBRICATION

Stewart-Warner Corp., Alemite Div.—Catalog describes new method of lubricating industrial machinery with "Oil-Mist." Bulk of publication taken up with engineering data, covering applications, operation, bearing application, bearing speeds of this method. Also for plain bearings, selection of condensing fittings, intermixing of condensers, bearing grooving and many other engineering data appropriate to the subject.

90 VALVES

Wm. Powell Co.—A 24-page condensed catalog (revised edition) illustrates and describes gate, globe, angle, check, Y, flush bottom tank, lubricated plug and other types of valves in bronze, iron, steel and corrosion-resistant metals and alloys. Available sizes and pressure-temperature ratings are also included.

91 WATER COLUMNS, GAGES

Ernst Water Column & Gage Co.—Bulletin 8-1-56 illustrates and gives specifications of bronze gages, flow indicators, water columns, steel gages and valves, gage glasses and gaskets.

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YOUR *New Catalogs* GUIDE

92 ELECTRICAL PRECIPITATORS

Research-Cottrell, Inc.—Cottrell automation system bulletin, eight pages, defines the term "Ideal Electrical Power" and demonstrates how this precipitator power level can be closely approached by automation.

93 SPEED REDUCERS

Cone-Drive Gears Div., Michigan Tool Co.—Details of double-enveloping worm gear speed reducers are presented in 24-page Bulletin CD-218. Stocked capacities of the line range from fractional to 665 hp, reductions from 5:1 to 70:1. Specifications on extended shaft and shaft mounted models, dimensioned assembly drawings, tables of mechanical and thermal hp, output torque and chain pull ratings are included.

94 CUSTOM MOLDING TEFLON

Sparta Mfg. Co.—A four-page brochure covers patented process of custom molding parts of Teflon in thin sections and shapes. Properties and characteristics of Teflon, suggested end uses, and illustrations of such parts designed through the process as cup, ball, or shaft seals, washers, gaskets and diaphragms are included.

95 FLOAT, THERMOSTATIC TRAP

Warren Webster & Co.—Bulletin B-1205 describes a new series of float and thermostatic traps for steam pressures to 150 lb per sq in. Traps are now made with $\frac{3}{4}$, 1 and $1\frac{1}{4}$ in. connections. Bulletin gives construction details, ratings and suggested specifications.

96 TECHNICAL BOOKS

Reinhold Publishing Corp.—A 68-page annual catalog lists books on materials engineering, metallurgy, automation, physics, plastics, lubrication, paints, fasteners, chemistry, and architecture. Books are classified by subject, and indexed by title, subject, and author. Each listing includes description and complete table of contents.

97 MOTOR REDUCER

Falk Corp.—Offers a revised Motoreducer Bulletin 3100, and a completely new Shaft Mounted Drive Bulletin 7100. Both are illustrated and contain complete information on types, sizes, horsepower, selection tables, dimensions, applications, accessories, and more.

98 BRONZE BEARINGS

Johnson Bronze Co.—A catalog lists and illustrates more than 900 sizes cast bronze bearings, 400 sizes of bronze bars, cored and solid, graphited bronze, powdered bronze in straight, flanged and self-aligning bearings, bearing babbitt.

99 INSTRUMENTATION

Leeds & Northrup Co.—Four-page folder and three individual data sheets illustrate and describe features of pressurized, high speed sampling system with new sampling averaging unit, and magnetic O_2 analyzer and electronic recorder. The equipment determines oxygen content in boiler flue gas.

100 COMPRESSOR VALVES

J.H.H. Voss Co.—Bulletin 53-G covers valves for air, gas or ammonia compressors. The valves are machined from solid stock; plates are machined and ground; valves and plates are of heat treated alloy or stainless steel and are Custom designed to fit the individual characteristics of the compressor for which they are manufactured.

101 INTERNAL DIAMETER BALLIZING

Industrial Tectonics, Inc.—Catalog BZQ-11 illustrates and discusses improvements in ballizing, the method for sizing and finishing holes by pressing a precision ball of suitable size and hardness through a hole. Production and cost advantages are cited, and samples of ballized parts and sizing balls are illustrated.

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LATEST INDUSTRIAL LITERATURE

102 DRAFTING DESK

General Fireproofing Co.—A folder illustrates and describes a drafting desk which has a belt positioning control and incorporates a reference area and storage space in one compact unit.

103 CONDENSERS, COOLERS

Niagara Blower Co.—Three bulletins are offered. No. 130 covers methods for cooling compresses air or gas consistently to below ambient temperatures; No. 131 shows benefits of panel construction in condensers with unit capacities of 100 to 240 tons refrigeration; No. 132 describes a self-contained, evaporative method of cooling liquids in a closed system.

104 STAINLESS, SPECIAL PURPOSE ALLOYS

Carpenter Steel Co.—A 12-page booklet contains information on selection, properties, corrosion resistance and workability of stainless steels. Also included is a description of alloys available for electronic, magnetic and electrical applications, and alloys for elevated temperature service.

105 FIRE PUMPS, FITTINGS

Peerless Pump Div., Food Machinery & Chemical Corp.—A 32-page bulletin, No. B-1500, describes, illustrates, and tabulates, with dimensional data, hundreds of models of Underwriters approved horizontal and vertical centrifugal fire pumps, fittings, and drivers for application to commercial and industrial risks. Addendum includes selection charts with data for each model.

106 TITESEAL COMPOUNDS

Radiator Specialty Co.—Brochure, 12 pages, describes Titeseal Pipe-sealing Compounds and the part they are playing in American Industry. The book gives properties and recommended uses.

107 BOILER SAFETY CONTROLS

McDonnell & Miller, Inc.—Bulletin P-30 describes installation of pressure relief valves, low water cutoffs and boiler water feeders for hot water space heating boilers.

108 DUST FILTERS

W. W. Sly Mfg. Co.—A 36-page Bulletin 104 describes dust filters and gives engineering information on dust control systems. Operating principles of the firm's Dynaclone are described, and dust filter system specifications and hopper and support data are included.

109 COLOR-PORT WATER GAGES

Yarnall-Waring Co.—Greater visibility and accuracy of reading boiler water pressures to 3000 psi is claimed for Color-Port water gages, described in six-page Bulletin WG-1814 (57). It explains how two-color readings work, tells how they are constructed, and shows how they are serviced.

110 PROCESS HEATERS

Pantex Mfg. Corp.—Bulletin 38-D illustrates and describes Speedytherm process heaters for high temperature, low pressure applications. The method circulates liquid at temperatures up to 500 F for heating presses, platens, rolls, and jacketed kettles.

111 SQUIRREL CAGE MOTORS

Sterling Electric Motors, Inc.—A 64-page catalog illustrates a-c squirrel cage motors, speed reducers, and variable speed drives. Featured additions are right angle gear motors, right angle variable speed drives, and an expanded range of variable speed drives from 4660 to 1.3 rpm in variations from 2:1 to 10:1.

112 FORGED STEEL GATE VALVES

Lunkenheimer Co.—Circular No. 607 describes new forged steel gate valves for service applications 800 psi at 850 F, 2000 psi at 100 F. They are made in screwed and socket welding end design. A large cutaway illustration shows design detail.

113 METAL HOSE

Flexonics Corp.—A 36-page design catalog covers application and selection of metal hose. Various end fittings are illustrated and described.

114 DROP FORGED COUPLINGS

Bonney Forge & Tool Wks.—New drop forged flats described in this bulletin are half couplings beveled for convenience, tapered for strength and ruggedness. In larger sizes, the flat Weldolet is designed to provide an integrally reinforced nozzle for vessel heads and caps.

115 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—A new 24-page, 3-color catalog, illustrated with comprehensive specifications on more than 500 types and sizes of standard miniature ball bearings from .059 in. to ½ in. OD, includes material of particular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

116 MACHINE DESIGN IDEAS

Lincoln Electric Co.—"Design Ideas" is a series of pamphlets issued periodically to design engineers, production men, and management executives. Series outline fundamentals of how to design with steel, to reduce costs and improve performance, with special charts and checking information. Case histories are presented to illustrate new ideas. Latest study discusses vibration.

117 COOLING TOWERS

Marley Co.—Bulletin DFA-58 details intermediate capacity cooling towers. Included are specifications of double-flow Aquatowers in Series 8, 12, and 14 models (both wood and steel structures). Dimensional drawings of towers and schematics of attachment of tower to grillage are included.

118 PRESSURE SENSITIVE INSTRUMENTS

Wallace & Tiernan Inc.—Eight-page publication TA-1006-A gives specifications and range charts on absolute pressure indicators; gage, vacuum and differential pressure indicators; mercurial manometers; pressure control equipment.

119 STEEL WIRE

American Chain & Cable Co., Page Steel & Wire Div.—A 16-page, DH-1226, catalog on Page shaped wire includes specification tables, range of sizes, physical properties of steel wire, table of standard wire gages, hardness conversion tables, with illustrations showing how to calculate areas of typical common shapes of wires. Size range includes cross-sectional area up to and including No. 3 BWG; flats and rectangles in widths up to ⅜ in., the ratio of width of thickness not exceeding 6 to 1.

120 PROCESS INDUSTRY TUBING

Babcock & Wilcox Co., Tubular Products Div.—A 16-page bulletin, TB-417, is an illustrated booklet presenting information on the application of tubing, pipe, and welding fittings in the process industry. Selection of materials, analyses, physical and mechanical properties of various tubing steels are included.

121 AUTOMATIC VALVES

A. W. Cash Valve Mfg. Corp.—An 82-page catalog describes and illustrates line of pressure reducing and regulating valves, relief valves, back pressure valves, hot water boiler control valves, anti-siphon vacuum valves, and strainers. Contains seven new items not previously included in former catalogs.

122 PROCESS INSTRUMENTATION

Fischer & Porter Co.—A 32-page catalog describes the company's products available for immediate shipment. Included are prices. It covers indicating, recording, controlling and transmitting instruments for flow, pressure and density.

123 MAGNETIC DRIVES

Whitney Chain Co.—Data on design, drive features, operating and performance curves, output torque rating-dimensions, selection chart, as well as photographs of installations and applications of magnetic drives are included in the brochure. The new self-contained permanent magnet type magnetic drives are described as fitting new NEMA frame specifications and range in horsepower from 1 to 15.

YOUR

New Catalogs

LATEST INDUSTRIAL LITERATURE

GUIDE

124 RIGID PVC PIPE

B. F. Goodrich Industrial Products Co.—Bulletin 10051-A covers properties, chemical resistance, design data, specifications, and installation of Koroseal rigid vinyl piping.

125 RUBBER PARTS

Goshen Rubber Co.—Eight-page brochure, in file folder form describes facilities of the firm for producing custom-made rubber parts and components. Laboratory facilities for compound developing, fabricating techniques for producing rubber products to close tolerances are shown, along with representative products.

126 HAND HOISTS, TROLLEYS

Yale & Towne Mfg. Co.—Catalog No. 1372B provides data on hand chain hoisting equipment in capacities from 1/2 to 40 tons. Monorail trolleys in plain and geared types in similar capacity range are also covered, along with information on selecting the proper type of hoisting equipment.

127 COMPACT PACKAGED BOILERS

Superior Combustion Industries, Inc.—Catalog describes features of Compact packaged boilers of four-pass design, 5 sq ft of heating surface per bhp and induced draft. Data and dimensions are included for 11 sizes from 20 to 200 bhp, firing oil or gas or both, and for pressures to 250 psi.

128 PROCESSING SERVICE PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 121-A describes SVS single stage, centrifugal pump developed for petroleum, petrochemical, chemical, and other processing services. Capacity ranges from 15 to 1300 gpm, discharge pressure to 600 psig, working pressure to 600 psig, differential head to 650 ft, temperature to 300 F, and speeds to 3600 rpm.

129 REFRIGERATING MACHINE

American Blower Div., American-Standard—Bulletin 1426, a catalog describing the Tonrac single-stage hermetic centrifugal refrigerating machine, shows in cutaway construction details, including condenser, single-stage compressor, marine type water boxes, evaporator, tube bundle, float valve, lubrication system, motor and purge system.

130 COUPLINGS

Snap-Tite, Inc.—Four bulletins and various data sheets cover couplings for high pressure systems, gravity flow systems, vacuum systems and hydraulic systems. Cutaway photos, diagrams and flow charts are included in the literature.

131 AUTOMATIC LIQUID LEVEL GAGES

Liquidometer Corp.—Bulletin 463A describes 100 per cent automatic remote reading tank gages. Included is information on direct reading gages at tank and hydrostatic type remote reading gages.

132 ROLLER CHAIN

Acme Chain Corp.—A new illustrated 100-page catalog covers precision roller chain and sprockets, flexible couplings, special conveyor attachments. Horsepower charts and standards, plus new engineering section showing diagrams of 36 methods of chain adjustments to assist in design and application problems are presented.

133 PVC FITTINGS, FLANGES, VALVES

Tube Turns Plastics, Inc.—Unplasticized polyvinyl chloride pipe fittings, flanges and valves are the subject of a new booklet. It discusses industrial applications of PVC piping and gives complete specifications for threaded and socket type of fittings and flanges, in both normal and high impact grades.

134 CYLINDERS, CONTROLS

Westinghouse Air Brake Co., Industrial Products Div.—Three bulletins are offered. F9-180.00 covers basic pneumatic air controls; DO-OO-2 lists catalogs covering the division's line of products; D3-41.01 describes double acting, cushioned and non-cushioned streamlined cylinders.

135 TECHNICAL DATA BOOKS

Lefax Publishers—Catalog contains descriptions of pocket-size technical data books on automotive engineering, diesel engineering, machine design, machinists' data, power transmission machinery, steam engineering, hydraulic, mathematics, and thermodynamics.

136 MISSILE FABRICATION

Alco Products, Inc.—A 20-page bulletin outlines engineering and manufacturing qualifications of Alco as a missile fabricator. It lists the company's association with electronic developments, its basic research facilities, and the acceptance of its thermal engineering systems for applications, incl. the "Honest John" rocket and "Terrier" missile.

137 CUSTOM ENGINEERED EQUIPMENT

Henry Vogt Machine Co.—Bulletin E-1 pictures equipment designed and built for petroleum refineries, chemical plants, power plants, and related industries.

138 BELT CONVEYORS

Jeffrey Mfg. Co.—Bulletin 909 on belt conveyors gives information on applications and selection. Tables on terminal selection are included, along with engineering data on idler spacing, slopes, curves, drives, speeds, and loading.

139 HUMIDIFICATION EQUIPMENT

Bahnson Co.—Catalog Section 104 details the firm's line of industrial humidification equipment. Information and pictures describe and show various types of steam and water humidification equipment. The different uses, capacity, function, and operation of each type is explained.

140 MECHANICAL PACKINGS, GASKETS

Raybestos-Manhattan, Inc., Packing Div.—Selected packing types designed for custom-built service on 95 per cent of all packing applications are the subject of this 40-page catalog. The book contains descriptions, illustrations, service recommendations, and specification charts that cover over 100 different products in packing and gasket materials.

141 DUST COLLECTORS

Bubar Dust Systems, Inc.—Four-page folder covers typical installations of dust collectors. A chart shows fan power required per inch draft loss based on 60 per cent fan efficiency, 85 per cent motor efficiency.

142 SPEED CONTROL VALVES

Hanna Engrg. Wks.—Single-page leaflet gives operational and dimensional details for new Flo-Set 1000 hydraulic speed control valves. Sizes are 1/4, 3/8, 1/2, and 3/4 in. Valves meter flow of petroleum base and synthetic hydraulic fluids and water, pressures to 1000 psi.

143 PVC PLASTIC PIPE

A. M. Byers Co.—A 30-page booklet contains corrosion ratings in 400 chemicals for Types I and II PVC, and eight ferrous, alloy, and non-ferrous metals. Technical data includes working pressures at elevated temperatures, head loss, and friction factors. Characteristics, applications, properties, and installation practices are described.

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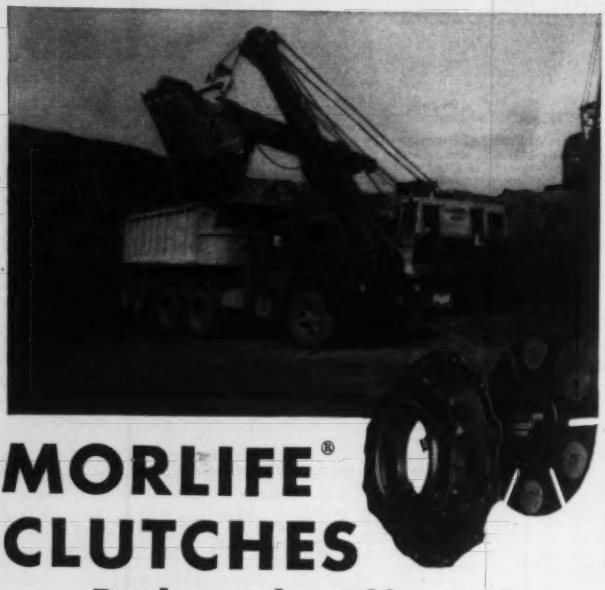

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CLUTCHES

YOUR New Catalogs GUIDE

144 POWER SCREW ASSEMBLIES

Horspool & Romine Mfg. Co.—Bulletin AT-1 describes Acme screw thread standards for general purpose and centralizing series of threads, shows limiting dimensions and tolerances for both series, discusses various classes of fits between male and female threaded parts, and solutions to backlash problems.

145 VIBRATION ISOLATION

Korfund Co.—A four-page bulletin gives information on how to write vibration isolation specifications for air conditioning and related equipment. It contains a definitive treatment of the factors involved in the selection of various isolation media commercially available and has a selector chart designed to simplify writing specifications. Bulletin F2C.

146 COPPER DRAINAGE TUBE

Chase Brass & Copper Co.—Publication G-23 (AIA File No. 29-B-4) details advantages of copper DWV drainage tube and fittings. Roughing-in dimensions to assist in planning drainage layouts, installation instructions, and instructions how to make a solder joint are included.

147 GLASS PROTECTED STACKS

A. O. Smith Corp., Process Equipment Div.—Bulletin SS-202A illustrates and describes Permaglas smokestacks which feature glass fused to steel on both the inner and outer walls of the stack. Data is given on installation, cost comparison, the firm's manufacturing facilities.

148 NUCLEAR FORGINGS

U. S. Steel Corp.—Six-page folder describes and pictures such forgings as rings, disks, closure heads, and vessel flanges, available for use in nuclear reactor construction.

149 PISTON, SEALING RINGS

Koppers Company, Inc., Metal Products Div.—A 24-page brochure illustrates and describes American Hammered piston and sealing rings for various types of industrial applications. Engineering data, tables, and types of material are included. Also available are 4-page folders on conformable oil ring, marine piston rings, chrome-plated piston rings, and piston rings for air and steam forging hammers.

150 CLEANABLE FILTERS

Cuno Engineering Corp.—Literature covers Auto-Klean and Super Auto-Klean edge-type cleanable filters, and filters for built-in installations, and Micro-Screen filter elements of reinforced screen mesh.

151 TUBE, BAR STOCK

Shenango Furnace Co.—Bulletin 156 gives information on standard bar and tube stock offered in GC Meehanite metal, GA Meehanite metal and Type 1 Ni-resist. A comprehensive physical properties chart is included.

152 HYDRAULIC HOSE

Flexonics Corp.—A 24-page catalog shows pressures and sizes of hydraulic synthetic hose. Fittings of swaged, factory crimped, and field attachable types are included.

153 ROLLER BEARINGS

Torrington Co.—New drawn cup roller bearing is described in six-page catalog. Detailed data on bearing design, installation, lubrication and load capacity are included, together with information on sizes available. Design features and typical applications are illustrated and described.

154 AIR CLEANING EQUIPMENT

Green Fuel Economizer Co., Fan Div.—The company offers three bulletins covering: (1) Aerodyne industrial dust collectors; (2) Aerodyne packaged dust collectors; (3) Sure-seal air filters.

155 DATA PROCESSING

Consolidated Electrodynamics Corp.—A 32-page general catalog, No. 1305, describes recording oscillographs and amplifying systems, direct writing oscillographs, vibration pickups, pressure pickups, magnetic tape systems, analog-to-digital conversion systems, and analytical and process control instruments including mass spectrometers, chromatographs, refractometers, leak detectors.

YOUR *New Catalogs* GUIDE

156 DRAWING PENCIL

Venus Pen & Pencil Corp.—Technical test-kit with two Venus Drawing pencils is offered. The firm says its colloidal process produces finer lead particles to insure a more even deposit on drawings. Homogenized lead is claimed to assure smoothness, eliminate scratching, hard-spots, and soft-spots.

157 PLUG VALVES

DeZurik Corp.—A 36-page catalog covers eccentric plug valves. It explains eccentric action principle, and describes 1/2 through 20 in. valves and accessories, pneumatic, hydraulic and electric operators, pipe line strainers, and indicates service recommendations for valves. Valves are illustrated and dimensions are listed with flow charts.

158 PACKAGE BOILERS

Combustion Engineering, Inc.—Catalog P-439 describes new Type VP package boiler, shop assembled to provide steam capacities from 4000 to 50,000 lb per hour. Space requirements and specifications are in table form.

159 CLAD STEEL EQUIPMENT

Lukens Steel Co.—A 28-page booklet covers the development, manufacture and properties of clad steels, the types of cladding materials available, design considerations, fabrication techniques and clad steel equipment applications.

160 VALVE-UNION

Worcester Valve Co., Inc.—Catalog WV 454 describes new Econ-O-Miser valve for positive leak-proof shutoff. It acts as both a valve and union. Comparative labor and materials costs for this valve and other types are given.

161 DIRECT CONNECTED FANS

Robbins & Myers Inc.—A 12-page pamphlet summarizing the design features and component parts of the Propellair fan. Included also are pictorial descriptions of some typical installations. In addition performance data for Propellair axial flow fans is charted. Also described is the Sky-Blast power roof ventilator.

162 GEARMOTORS

Western Gear Corp.—Catalog 5806 gives information on integral and all-motor types of straight-line gear-motors. Standard units are available to 50 hp, double and triple reduction.

163 DRAFTING MACHINES

Charles Bruning Co.—"The Finest in Drafting Machines," a 20-page illustrated booklet, explains the cost and time-saving advantages offered by drafting machines in mechanical drawing, and describes and illustrates models and construction features. A list of available scales is included.

164 PRESSURE VESSELS

Koven Fabricators, Inc., Div. of L. O. Koven & Brother, Inc.—Bulletin No. 550 illustrates and describes mixers, kettles, vacuum and pressure vessels, autoclaves, evaporators, impregnators, condensers, stills, extractors, tanks, standpipes, piping, stacks.

165 TORQUE WRENCH SLIDE RULE

P. A. Sturtevant Co.—A slide rule for calculating conversion factor for torque wrenches used with adapters and extensions is offered. Range of rule covers practical torque wrench and adapter combinations for determination of proper conversion constant.

166 PRINTED TAPES, TEMPLATES

Chart-Pak, Inc.—A 24-page catalog illustrates and describes pressure-sensitive printed tapes, templates, workboards, and other chart materials.

167 SPEED REDUCERS

Winsmith, Inc.—Catalog 155, 112 pages, covers more than 150 models, including the recently introduced "C" series. It contains engineering selection data and is sectionalized for quick and easy reference to all information. A special general engineering section is included to aid in solving application problems.

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UP-TO-THE-MINUTE Conscientious editing and access to the latest developments in engineering keeps MC vigorously up-to-date. For instance, the current (1958) edition contains 23 *new* product listings in the field of Nucleonics.

Have you requested a copy of the 1958 edition? It's yours for the asking—but the supply is dwindling fast so fill in and mail the coupon today.

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*Principal Product or Service*_____

YOUR New Catalogs GUIDE

168 LUBRICATED PLUG VALVES

Ohio Injector Co.—Form 197R covers bronze, iron, cast steel, forged steel, and lubricated plug valve lines in a condensed form. They are classified by type and pressure class and illustrated. Face-to-face dimensions for each size and type of valve listed are included.

169 FIN RADIATION

Moore Dry Kiln Co.—Bulletin 5308-R illustrates and describes a steel-finned pipe for heating and cooling applications. Surfaces are formed by spirally wound coils of heavy gage steel strip, corrugated on inner edge.

170 ROTARY JOINTS

Seamlex Co.—Eight-page Bulletin 5500-B describes rotary joints for steam, water, and air. Information on mechanical construction, engineering features, operating results is included with diagrams illustrating three engineering principles responsible for triple protection against leakage.

171 SEALED BEARINGS

Stephens-Adamson Mfg. Co., Sealmaster Bearings Div.—Bulletin 455 illustrates and describes the firm's Sealmaster bearings. Standard and special units are available. Cutaway photos show such features as zone hardening, locking pin and perimeter dimple, labyrinth seal, ball retainer.

172 COUNTING DEVICES

Veeder-Root, Inc.—Modern mechanical and electrical counters for all industrial and special counting requirements are briefly described in a four-page condensed general catalog. Also contains information on applications and how-to-order.

173 TOOL STEELS

Crucible Steel Co. of America—A 14-page bulletin covers application of tool steels for metal forming, stamping and trimming dies, application of high speed steels for single and multiple point cutting tools, and shop maintenance.

174 CYLINDERS

Ledeen Mfg. Co.—A 12-page bulletin illustrates and describes the company's line of cylinders for air, oil, water, gas or steam operation in medium, heavy and super-duty construction. Selection information, ratings and limitations, and rod and head attachments are included.

175 BLAST CLEANING UNITS

Pangborn Corp.—"Blastmaster Rotoblast Barrels" describes airless blast cleaning equipment. It illustrates from $1^1/_2$ cu ft capacity to 27 cu ft. Dimensions and description of how the units work and sections on an abrading unit, an abrasive reconditioning system, construction features and the barrel's adaptation to automation are included.

176 ABSORPTION REFRIGERATION SYSTEMS

Black, Sivalls & Bryson, Inc.—Catalog 33-10 describes new ammonia absorption refrigeration unit for gas processing that requires temperatures below ordinary atmospheric level. The unit can be used for hydrocarbon dewpoint control in pipelines, to increase hydrocarbon recovery with low temperature separation units where there is no available pressure expansion, and to increase gasoline plant hydrocarbon recovery up to 100 per cent by chilling the absorption oil.

177 GAS-FIRED HEATERS

Reznor Mfg. Co.—Bulletin GN-57 gives specifications, dimensions and application and installation information on gas-fired unit heaters and duct furnaces. Capacities on unit heaters range from 25,000 to 300,000 Btu. Individual unit capacities for duct furnaces range from 50,000 to 300,000 Btu; system capacities in excess of 2,000,000 Btu are obtainable through sectional assembly.

For Consulting Engineers

Turn to Page 240

YOUR *New Catalogs* GUIDE

178 MECHANICAL FORCE GAGE

W. C. Dillon Co.—Bulletin 11E illustrates and describes Model X mechanical force gage for precision measurement of pressure, tensile, or torque. More than 25 applications are illustrated and dimensions are diagrammed.

179 WATER SOFTENERS

Cochrane Corp.—A 20-page publication, No. 4520, deals with the necessity for water softening, explaining the fundamentals of softening and selection of equipment and zeolites. The bulletin also describes the operation of the firm's hydromatic valve for manual or automatic control of the cycling of the process.

180 RUBBER MOUNTED ASSEMBLIES

Bushings, Inc.—Three catalogs illustrate and offer engineering data on rubber mounted bearings and bushings, machinery mountings and pillow blocks.

181 VACUUM FOR INDUSTRY

Spencer Turbine Co.—Bulletin No. 155, 12 pages, on vacuum for industry contains complete descriptions of stationary and portable vacuum equipment. New features include a table for the rough calculation of the horsepower required for any specific job, and outline of the latest methods of automatic and hand dumping of refuse, a section on the application of vacuum to machine design, and illustrations of the special vacuum tools used in industry.

182 BOILER SAFETY DEVICES

Reliance Gauge Column Co.—Bulletin 516 is a condensed catalog of water columns, water-level gages and accessories, and liquid-level alarms. It is a key to more complete catalog sections describing this class of equipment as made by Reliance.

183 STEAM GENERATORS

Ames Iron Wks., Inc.—Bulletin GB-1 describes how generators have helped solve boiler room problems. The advantages of compact, simple and efficient design of complete packaged boilers are shown being put to use in plants across the nation.

184 BELT CARRIERS

Stephens-Adamson Mfg. Co., Standard Products Div.—Bulletin 355 lists carriers for belt conveyors and shows their application in industry. Cross sections and dimension tables are given for the various carriers.

185 COPPER, COPPER ALLOY

American Brass Co.—A new edition of a 24-page reference manual contains copper and copper-alloy specifications, including ASTM, ASME, AWS, SAE, AMS, federal, military, Navy, and joint Army-Navy specifications.

186 COMPRESSED AIR UNITS

Hankison Corp.—A 20-page catalog describes construction, operation and performance of compressed air units, combination condenserfilter for instrument air, dehydrofilter for vapor-free air lines, condensate discharge trap.

187 SUMP, PROCESS PUMPS

Goulds Pumps, Inc.—Bulletin 726.2 describes a new group of vertical centrifugal pumps especially designed for sump and process work. Single and duplex units can be supplied for wet pit or dry pit construction. Single units range in capacities up to 1080 gpm and for heads up to 290 ft, for pit depths to 20 ft.

188 HYDRAULIC FLUIDS

E. F. Houghton & Co.—Folders describe a new series of fire resistant hydraulic fluids supplementing the aqueous base fluids marketed by the firm. These are phosphate ester type fluids that have been fortified by the addition of materials to increase oiliness and rust prevention.

189 HEAT AND POWER REFRACTORIES

Norton Co.—Thirty-two page brochure compiled for the benefit of boiler operators, setters, and engineers—to aid them in solving refractory problems and to help them obtain greater efficiency from their boilers. Also included is a temperature conversion chart, "Crystolon" brick specification tables and a quick-figuring efficiency chart for boilers.

...BY TITUSVILLE!

3pass

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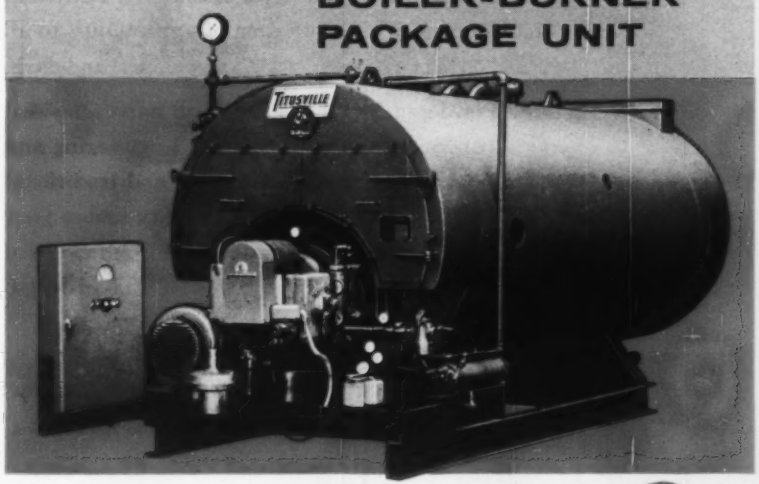

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As pioneer and master-builder of Scotch Marine type boilers, TITUSVILLE is proud to present the 3-PASS boiler-burner package unit for high and low pressure and hot water. Offering the highest efficiency obtainable, these new 3-Pass boilers provide economy in service so great as to return the entire investment cost over a few years of operation. Designed for use with any of the leading makes of burners, and for gas, oil, or gas-oil combinations, Titusville 3-Pass boiler-burner units are available in ten sizes, with heating surfaces from 358 to 3571 sq ft. Write for the facts, and a quotation on your requirements.

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Manufacturers of A Complete Line of Boilers for Every Heating and Power Requirement
Plants at Titusville, Pa. and Warren, Pa.
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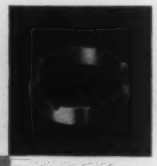
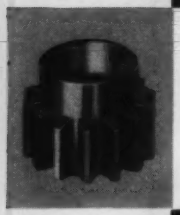
BEARING DESIGN and APPLICATION

The inauguration of Bunting's new facility for engineering and manufacturing bearings and parts of Sintered Powdered Metals opens a wide new area of opportunity to all mechanical industry.

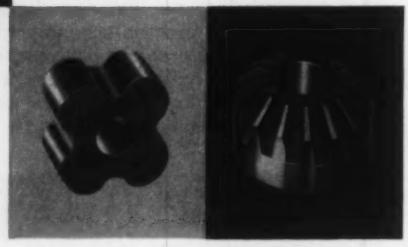
Sintered Powdered Metal Bearings and parts offer real economies in design. Bunting Engineering and manufacturing skill and traditional technical responsibility assure your most advantageous use of this material.





A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command, comprehensive data and facts based on wide experience in the designing and use of both Cast Bronze and Sintered Powdered Metal Bearings and parts.

Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.



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YOUR New Catalogs GUIDE

190 DRAFTING SYSTEM

Universal Drafting Machine Corp.—Literature covers a new portable drafting system, consisting of a personal size professional drafting machine, folding drawing board, metal scales, instrument box and travel case, which can be set up on a desk in two minutes. The system called Desk-Topper, is designed for use at home, in the office or hotel room, or on planes or trains.

191 OIL, FLUID SEALS

National Seal Div. Federal-Mogul-Bower Bearings, Inc.—Catalog 58 covers selection, application, maintenance of 40 different types of oil and fluid seals. More than 3000 sizes are listed.

192 DEMINERALIZER PLANTS

Hungerford & Terry, Inc.—Four-page bulletin contains information and photographs on demineralizer installations. Names, addresses, types and capacities of present installations in practically every state are listed.

193 BRAKES, CLUTCHES, CONTROLS

Warner Electric Brake & Clutch Co.—Eight-page catalog digest, No. 6292, covers electric brakes, clutches and controls for miniature mechanisms of high torque machine drives.

194 DIESEL ENGINES

Alco Products, Inc.—Bulletin DE-6 presents specifications, fabrication features of Model 251 diesel engines. Bulletin contains foldout with cross-section and captioned illustrations of major components of 6-cylinder in-line engine and 12 and 16-cylinder Vee-type engines.

195 CENTRIFUGAL CASTINGS

Sandusky Foundry & Machine Co.—Catalog No. 200 explains how the centrifugal method produces a fine-grain, dense structure free of gas bubbles, slag, and non-uniformities, with desirable physical properties for circular or symmetrical parts. The firm's facilities for producing and machining cylinders in sizes from 7 to 54 in. OD, light or heavy-walled, up to 33 ft in length, are described. Comprehensive alloy tables list characteristics of more than 70 stainless steel, steel, and nonferrous alloys available, and 86 present applications in 13 major industries are given.

196 FUEL CELL FASTENER

Waldes Kohinoor, Inc.—A 7-page catalog provides engineering data and specifications for the company's Waldes positive lock fastener, which is used to hold airplane fuel cells in place without piercing the cell wall on installation. Illustrations and charts explain the use and method of application for the device.

197 STEEL TUBING

Bundy Tubing Co.—A 12-page catalog contains technical information on physical properties, available sizes and method of manufacture of steel tubing. Also included are possible applications and methods of fabricating.

198 INDUSTRIAL LIQUID METERS

Neptune Meter Co.—A 28-page liquid meter bulletin, No. 566, contains selector charts which tell how to pick the right meter and register for more than 150 typical liquids. It describes the firm's Auto-Stop, repeating Auto-Stop, ticket-printing features and electric Auto-Switch for operating pumps.

199 SYNTHETIC RUBBER

B. F. Goodrich Chemical Co., Div. of B. F. Goodrich Co.—"Everywhere in Industry—Hycar American Rubber," 24 pages, describes Goodrich Hycar rubber and its properties, using text and tables. General applications and uses are suggested for the different types and blends available.

200 THERMOCOUPLE REFERENCE JUNCTION

Pace Engineering Co.—Data sheets describe a precision and a utility series of Thermocouple Reference Junctions for multi-channel temperature measurement systems. A discussion of special circuit features and Thermocouple combinations is included, as well as specification on temperature stability and uniformity among channels.

YOUR *New Catalogs* GUIDE

201 ELECTRIC CLUTCH

I-T-E- Circuit Breaker Co., Transformer-Rectifier Div.—Four-page Bulletin ECP-656 illustrates and describes electro clutch developed to connect or disconnect a driven shaft or gear from a driving shaft, either running or standing still. Photos show industrial applications.

202 CRANES, HOISTS

Detroit Hoist & Machine Co.—Bulletin 795 covers air and electric cranes and hoists for use in chemical plants, oil processing, and missile applications.

203 WOOD, STEEL DOORS

Kinnear Mfg. Co.—Catalog data book discusses and illustrates advantages, economy, construction features, general specifications of wood and steel upward-acting doors. Information on installation, clearance requirements, methods of operation, controls, and adaptability is included.

204 BRONZE, IRON VALVES

Fairbanks Co.—New Catalog 57 provides descriptions and specifications on complete lines of bronze and iron body valves. Bronze valves of all types, including solder and brazed end valves with pressure ratings from 125 to 300 lb steam are covered. Iron body valves of all types, including AWWA and Underwriters Approved, with pressure ratings from 125 to 250 lb steam are listed.

205 SUPER REFRACTORIES

Carborundum Co., Refractories Div.—"Properties of Super Refractories," twenty-four pages, covers latest data on super refractories including newly developed compositions for specialized applications. Re-frax silicon-nitride bonded silicon carbide refractories which can be produced in intricately designed shapes to close dimensional tolerances is described. Chemical analysis and physical property charts are provided on all materials.

206 STUD WELDING

Nelson Stud Welding Div., Gregory Industries, Inc.—A manual covers designing, materials, specifications, dimensions and physical properties of the materials used in the Nelweld method of welding studs.

207 LONG TRAVEL RETRACTING SOOT BLOWER

Diamond Power Specialty Corp.—Bulletin 2111 describes new Series 300 IK long travel rectracting soot blowers, for cleaning boiler tube banks in very hot locations. Positive drive by single, enclosed air or electric motor. Improved nozzle provides better cleaning with greater economy. Positive closed pitch helical blowing pattern assures full coverage of all surface.

208 ADJUSTABLE-SPEED DRIVES

Dynamatic Div., Eaton Mfg. Co.—Data Sheets DS 1, 2, 3, 4 and 5 describe a new line of stationary-field, air and liquid-cooled drives that provide infinitely adjustable speeds from an a-c power source. Included are integral, motor and coupling combinations from 3 to 75 hp and separately mounted couplings up to 2,000 hp.

209 STEAM TRAPS, FLUID SPECIALTIES

V. D. Anderson Co.—A 36-page catalog contains engineering information on sizing steam traps, strainers, air release valves, and line type purifiers. Specifications, capacities, sizes, pressures, weights on inverted bucket, thermostatic, float, combination and high pressure steam traps and other fluid specialties are given. Piping layouts are included.

210 ROLLING MILLS

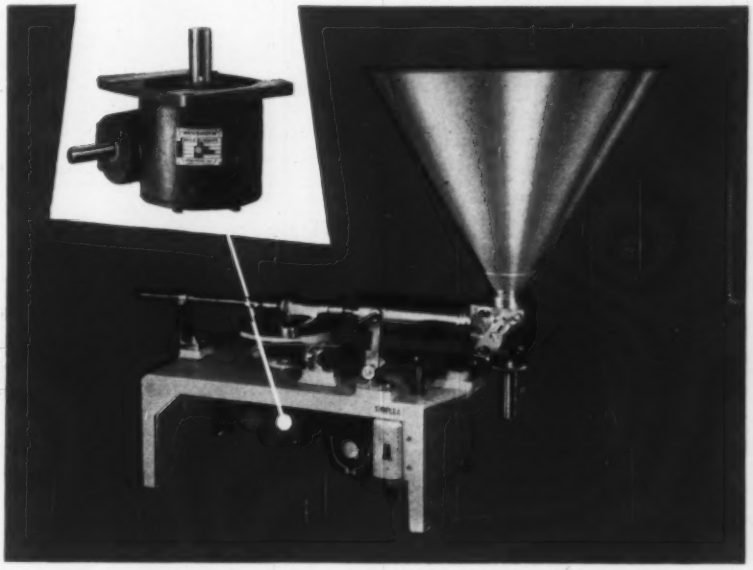
Loewy-Hydropress Div. Baldwin-Lima-Hamilton—Bulletin 14.003 shows some outstanding rolling mill equipment—blooming, slabbing, structural, and strip mill installations, merchant and bar mills, taper and wire-rod mills—and Loewy's large Baldwin-Lima-Hamilton shop facilities which insure fast deliveries.

211 FRICTION MATERIALS

Johns-Manville—A 16-page brochure, FM-35A, gives descriptions, design data, characteristics, and a reference chart of industrial friction materials including asbestos brake blocks, linings, and clutch facings.

Winsmith speed reducers help simplex piston fillers

pack semi-solids in a hurry!



• *Simplex Table Model "A" Piston Filler, driven by Winsmith "CV" Single Reduction Worm Gear Reducer of 60:1 ratio. Drive motor is ¼ h.p. 1750 rpm, single phase.*

SIMPLEX PISTON FILLERS are "force-feeding" semi-solids into containers at profitable speeds in hundreds of food packing and process plants. Manufactured by F. L. Burt Co., San Francisco, they are cycled to necessary precision by Winsmith Speed Reducers.

WHY WINSMITH? Says President F. L. Burt: *"Winsmith was the first company with a wide range of sizes to fit our needs from stock."* This includes outputs from 1/100 h.p. to 85 h.p. in ratios from 1.1:1 through 50,000:1 in full choice of shaft and mounting arrangements — such a complete selection that you're practically getting "custom" units from standardized stocks! Other big advantages of designing Winsmith Speed Reducers into your product are high output efficiency — maximum torque for the size of the package — dependability established over half a century.

WINSMITH SPEED REDUCERS

WRITE TODAY for Catalogs 155 and SM 57. See the "extras" that are standard in the Winsmith line!

WINSMITH, INC.

20 Eaton Street, Springville, (Erie County), N. Y.

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

212 O-RINGS

Linear Inc.—Compact 16-page folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes contain general recommendations on clearances, design material, machining, and finishes for most O-ring applications. A special compound bulletin describing the latest polymers and synthetic rubbers from which O-rings can be molded is also included.

213 RUST PREVENTION

Rust-Oleum Corp.—A general catalog contains 103 color chips showing colors available in primers, short oil type coatings, oil field finishes, restful color group finishes, machinery and implement colors, long oil type coatings, Galvinoleum coatings, heat resistant coatings, chemical resistant coatings, floor and deck coatings.

214 TEMPERATURE CONTROLS

Fenwal Inc.—Detailed folders describe devices for temperature detection, indication and control. Included are Thermoswitch and snap action local controls, remote bulb and capillary units, Detect-a-Fire and electronic thermistor controllers.

215 POWER TRANSMISSION

Ohio Gear Co.—A 186-page handbook on power transmission contains engineering charts, tables, and formulas on selection of gears and speed reducers. Dimensions of standard spur, bevel, spiral, helical, worm gears, and steel rack are tabulated.

216 FORCED, INDUCED DRAFT FANS

Green Fuel Economizer Co., Fan Div.—The company offers bulletins covering: (1) mechanical draft fans; (2) airfoil type fans; (3) fly ash collectors; (4) economizers.

217 STAINLESS AND HIGH ALLOY PIPE AND TUBING

Trent Tube Co., Subsidiary of Crucible Steel Co. of America—A 48-page manual detailing the complete operation of Trent Tube, manufacturers of Contour Trentweld, stainless steel and high alloy pipe and tubing. Included is information on Tubing Classifications—plus charts and tables applying to each class. Corrosion characteristics, weights, properties of alloys and conversion tables are also included.

218 PACKAGED STEAM GENERATORS

Union Iron Works—A 16-page bulletin, MH 3-54, describes Union Type MH packaged water tube steam generators equipped for oil or gas firing or both, with automatic, semi-automatic or manual combustion controls. Included are cutaway illustrations, tube arrangement layouts, photosequence story of actual shop assembly and dimension tables for 13 standard sizes from 10,000 to 60,000 lb of steam per hour.

219 BALL BEARINGS

New Departure Div., General Motors Corp.—A 36-page booklet illustrates and describes miniature precision instrument ball bearings. Data is given on each series, along with engineering and performance information.

220 OIL FILTERS, STRAINERS, OILING DEVICES

Wm. W. Nugent & Co., Inc.—Seven bulletins: No. 6 illustrates and describes Nugent pressure strainers; No. 7 gravity filters; No. 7A pressure filters; No. 8 tanks, pumps, shaft oilers; No. 14 oiling and filtering systems for turbines, paper mills, steel mills, pumps, compressors; No. 15 oiling devices; No. 16 sight feed valves, multiple oilers, flow indicators, sight overflows, and compression union fittings.

221 DEAERATORS

Permutit Co.—Bulletin No. 2357 describes the company's spray type deaerating heater. The principles of deaeration and the part it plays in corrosion prevention are described and illustrated. The deaerating heater is designed to protect equipment from corrosion by removing oxygen, carbon dioxide and nitrogen.

222 SPREADER STOKERS

Hoffman Combustion Engineering Co.—Catalog No. 55-CAD describes and illustrates features of moving-grate spreader stokers. Catalog 55-PDG describes, illustrates, and supplies additional information on spreader stokers with dumping grates. Capacities from 20,000 to 500,000 lb of steam per hour.

223 PIPE HANGERS

National Valve & Mfg. Co.—Bulletin 157 gives specifications for Counterpoise hangers, designed to provide a constant load supporting capacity for piping systems subject to vertical movement caused by expansion and contraction of piping with temperature changes. Levelglide hangers, which permit horizontal movement of piping systems, also are described.

224 ASH SLUICING SYSTEM

United Conveyor Corp.—A four-page bulletin, No. 1S-57 describes recirculating closed circuit ash sluicing system with description of principle and sequence of operation.

225 REFRACTORY GRAINS

Norton Co.—A 24-page pamphlet detailing the methods whereby Norton refractory grain is produced. Also summarized are the chemical and physical characteristics, sizes available, packing methods, and the many commercial applications of refractory grain.

226 DEHUMIDIFIERS

Pittsburgh Lectrodryer Div., McGraw-Edison Co.—Bulletin 227 covers application, installation, and operating data for equipment designed for maintaining lower than normal relative humidities in rooms. The bulletin stresses design and simplicity of operation of the unit, lists examples of advantages of controlled dehumidification in handling, storing, and packing of moisture-affected products.

227 GRATING-FLOORING AND TREADS

Irving Subway Grating Co., Inc.—Catalog F-400 contains illustrations, descriptions and engineering data on grating-flooring, treads, and floor armoring (riveted, press-locked, welded types) for industrial and power plants and refinery walkways, stairways, driveways, trucking aisles; ship cat-walks and engine room floors and treads; locomotive, freight and passenger car runways and treads; roadway armoring expansion joints catch basin covers; bridge decking.

228 TORQUE CONVERTERS

Twin Disc Clutch Co.—Bulletin 508 describes a new line of single-stage torque converters. Illustrations and diagrams to permit tentative selection of a torque converter for industrial engines ranging from 30 to 205 hp.

229 AIR METHOD PROCESSING

Niagara Blower Co.—Bulletin 135 illustrates and describes apparatus using the air method to remove heat from liquids or vapors for process cooling, flash cooling, vacuum distillation, condensing, refrigeration, and air liquefication.

230 GLASS-BONDED MICA

Mycalex Corp. of America—A revised engineering data file, contain technical information, design considerations and suggested applications of the company's Supramica ceramoplastic and Mycalex glass-bonded mica products. Charts of electrical and thermal characteristics and tabular data on the physical properties of the materials are included.

231 SPEED REDUCERS

Stephens-Adamson Mfg. Co.—Catalog 643 covers single and double reduction type speed reducers. Specifications and dimensions are tabled, and installation information is given. A section of the 12-page booklet deals with the firm's materials handling equipment.

232 MACHINE TOOLS, LATHES

R. K. LeBlond Machine Tool Co.—Catalog describes and illustrates machines by the builder of a complete line of lathes. Heavy duty, roll turning, tool room, standard duty, sliding bed gap, hollow spindle, rapid production, crankshaft, regal, dual drive lathes and new rapid borer are reviewed. Included also is the firm's Hydra-Trace duplicating attachment.

Progress in Propulsion at Marquardt

by Roy E. Marquardt, President

In all of the complex of modern weaponry no area affords more challenge than the field of supersonic and hypersonic propulsion. Here, where the stringent requirements for engine weight, size and thrust are creating problems of critical consequence, Marquardt engineers and scientists are making continuous progress.

The supersonic ramjets now being produced at our new Ogden, Utah, manufacturing facility provide the flight power for the Boeing Bomarc interceptor missile. Under John Winter, our chief engineer in powerplants, Marquardt engineers spent many thousand engineering manhours, to make this engine the fastest and most efficient air breathing engine in our defense arsenal.

Two Marquardt ramjet engines sustain the flight of the Bomarc after it is launched vertically into the air. The ramjets provide a range that allows the weapon to destroy enemy bombers at a far greater distance than any other missile presently in use in air defense.

The Bomarc application is only one of the many propulsion projects now underway at Marquardt. Currently under development are several advanced supersonic ramjet engines for application on future weapon systems.

Other activities are advancing man's knowledge of hypersonic propulsion, special high energy fuels, and Aircraft Nuclear Propulsion.

Engineers and scientists with a vision for the future are invited to investigate the opportunities at Marquardt. Address your inquiries to Jim Dale, Professional Personnel, 16550 Saticoy Street, Van Nuys, California.

Roy E Marquardt

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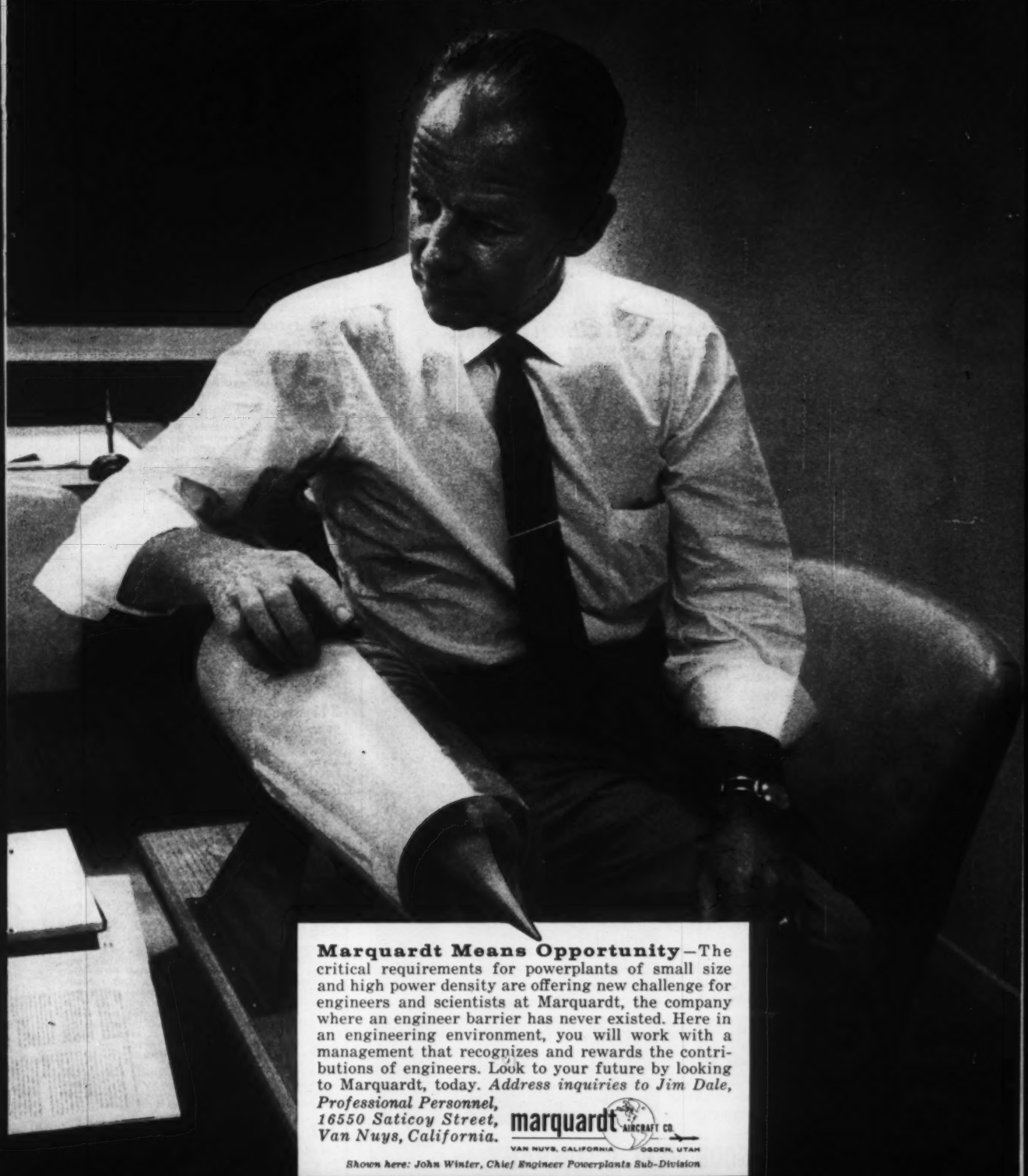
To Powerplant Engineers Facing an ENGINEER | BARRIER*



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Shown here: John Winter, Chief Engineer Powerplants Sub-Division

* ENGINEER | BARRIER—an achievement level beyond which you cannot advance

YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

233 UNIT STEAM GENERATOR

Preferred Utilities Mfg. Corp.—A 26-page booklet illustrates and describes the design and construction features of unit steam generators. Application photos, checklists and dimension tables are included.

234 STEAM SURFACE CONDENSERS

Maryland Shipbuilding & Drydock Co., Industrial Products Div.—A brochure describes products and experience of the company in the heat transfer and fabricated-machined component parts manufacturing capital equipment industry. Emphasis is on steam surface condensers.

235 COOLANT EQUIPMENT

Bijur Lubricating Co.—Literature describes Spraymist coolant equipment. Air filter, trap, regulator, gage, solenoid-valve, conduit box, pressurized coolant reservoir and filter are included with the equipment.

236 DRAFTING ROOM EQUIPMENT

Hamilton Mfg. Co.—Catalog No. 15 lists steel and wood drawing tables and files for every drafting room need. It includes comprehensive data on the Auto-Shift drafting table, and information about the "L" table and shallow-drawer unit with tracing lifter.

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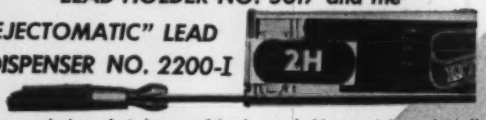

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237 TURBINE PUMPS

Aurora Pump Div., New York Air Brake Co.—Current line of centrifugal and turbine-type pumps is presented in a condensed catalog. A selection guide indicates which types of pump will meet certain capacity and head demands. A bulletin guide for more detailed information is included.

238 REPRODUCTION FILM

E. I. du Pont de Nemours & Co., Photo Products Dept.—Six-page folder (A-4629) describes properties and uses of the three Cronaflex films: direct positive, contact, and projection. The film is a new line developed especially for the reproduction of drawings, plans, and maps.

239 PROCESS HEATING EQUIPMENT

Union Iron Wks.—A four-page folder illustrates and describes vaporizers and forced circulation liquid heating and cooling units for use in the process industries. Diagrams and dimension tables of the units are included.

240 ROTARY POSITIVE GAS PUMPS

Roots Connersville Blower Div., Dresser Ind.—Bulletin 31-B-17 covers rotary positive displacement gas pumps 7-in. gear diameter and smaller. Selection tables, dimensions, performance data and illustrations for 18 standard sizes are included.

241 PENCIL SELECTOR

Eagle Pencil Co.—A booklet explains the fundamentals of pencil quality and tells how to select the proper pencil for manifold forms, legal forms, duplicating machines, checking, marking, steno use, charting graphs, blueprint marking, drafting, and general writing.

242 ELECTRICAL HEATING UNITS

Edwin L. Wiegand Co.—Booklet illustrating and describing 101 ways to apply electric heat and showing approved methods of electrically heating liquids, air, gases, machine parts and process equipment. All items are illustrated and described in detail and varied applications are shown. The heating units go under the trade name of Chromlox.

243 STRUCTURAL INSULATING PANELS

Philip Carey Mfg. Co.—Form No. 6301 provides data on a rigid, structural material that also insulates for walls, roof decks, partitions. It is made by bonding asbestos-cement board to both sides of a specially processed asphalt-treated insulation board. The material is described as lightweight, water-resistant, approximately 60 per cent light reflectivity, won't rust nor rot and needs no preservative treatment or painting.

244 ROTARY BLOWERS

Roots Connersville Blower Div., Dresser Ind.—Bulletin AF-154 describes rotary positive blowers 7-in. gear diameter and smaller. They are rated from 1 to 7 psig and will handle from 10 to 700 cfm of air. Eighteen standard sizes are listed.

245 FLEXIBLE COUPLINGS

Ajax Flexible Coupling Co.—Catalogs totaling 64 pages cover the firm's entire line of flexible couplings, including dihedral gear type with misalignment capacity up to 6 deg and rubber-bronze cushioned couplings for direct connected machines. Dimensional and capacity data is given. Catalogs describing vibrating conveyors and packers are also available.

246 OIL AND GAS BURNERS

Engineer Co.—Bulletin OB-63 illustrates different types and sizes of gas and oil burners and includes engineering data and specifications for pumping and heating sets for all types of liquid fuels.

247 INSTRUMENTS, CONTROLS

Leeds & Northrup—Booklet ENT lists the company's publications on instruments for research, teaching, and testing; instruments and controls for industrial plants and power plants; and heat-treating furnaces.

248 BALL BEARINGS

T. B. Wood's Sons Co.—Life-Lube bulletin No. 7100 illustrates with dimensional information pillow blocks, flange units, take-up units. These standard 200 series bearings with wide inner ring, deep ball race groove are lubricated for life at the factor. They are completely self-aligning. Sizes range from $1/2$ to $2\,15/16$ in.

249 GENERAL SERVICE PUMPS

C. H. Wheeler Mfg. Co.—Five bulletins are offered. D-100 and E-100 cover general service pumps; E-101 covers nonclog sump pumps; F-100 covers vertical nonclog pumps; F-101 covers horizontal nonclog pumps.

250 ECONOMY BOILER

Francis Economy Boilers, Div. Francis Steam Generator Co.—A 4-page bulletin illustrates and describes features of an automatic gas-fired water-tube boiler with fast recovery for such applications as dry cleaners, laundries, bakeries, canneries, milk product plants, dairies, wineries, bottling plants, food processors, tire retreaders, feed mills, institutions. Diagrams show a dual circulation system and a preheated feed-water system, 5 to 60-hp, gas fired, 100 to 150 psig mwp.

251 SHORT RETRACTING SOOT BLOWER

Diamond Power Specialty Corp.—Bulletin 1079A describes improved Model IR short retracting soot blower for cleaning water cooled boiler furnace walls, hopper slopes or narrow portions of tube banks adjacent to walls. Operates in extremely hot zones. Air motor, electric motor or manual operation. Automatic cycle.

252 HOT PROCESS SOFTENERS

Cochrane Corp.—Bulletin 4800 illustrates and describes hot process softeners for boiler plant water conditioning. Data is given on water treatment and the principles of operation of the firm's equipment are diagrammed.

253 AIR DIAPHRAGM CYLINDERS

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes diaphragm air cylinders and diaphragm air chambers with effective areas from 9 to 50 sq in. and strokes from $1\,1/4$ to 4 in.

254 CHART PAPERS

Technical Charts, Inc.—A revised set of "Technical Notes" includes 16 different bulletins describing specifications for standard and special recording charts. Subjects cover various types of paper available, including heat-sensitive and electro-sensitive, strip chart core and punch sizes.

255 SURFACE CONDENSERS

Worthington Corp.—Bulletin W-200-B3A shows applications of surface condensers for steam power stations, industrial processes, marine and water works service.

256 COLD ROLL FORMING

Yoder Co.—An 88-page reference manual on cold roll forming covers operating speeds, tooling, personnel training and operating techniques, surface finish, uniformity, forming of pre-coated stock, selecting proper equipment.

257 RETAINING RINGS

Waldes Kohinoor, Inc.—A new 8-page catalog supplements the company's 52-page catalog covering Waldes Truarc retaining rings. The two catalogs include 33 pages of engineering and specification charts, 6 pages of field applications and case histories, 20 pages devoted to Truarc pliers, assembly, and accessory tools, and other relevant information pertaining to the most advantageous use and selection of the rings.

258 VARIABLE SPEED DRIVES

Sterling Electric Motors, Inc.—An 8-page bulletin illustrates and describes variable speed drives for metal working, mixing, pumping, materials handling and continuous processing. Engineering, selection and operating data is included. Also available is a revised price sheet.

259 STEAM GENERATOR

Erie City Iron Works—Catalog SB-59 describes the firm's Keystone steam generator which has been designed as a baffleless, pressurized two-drum water tube packaged unit. The unit is said to be completely integrated and requires no field piping, wiring, brickwork, or special foundation.

260 MARKING EQUIPMENT

Jas. H. Matthews & Co., Inc.—Four supplements to catalog 146 include 21 pages describing hand marking stamps and tools; 16 pages describing steel marking dies; 19 pages describing marking machines; 17 pages describing identification checks, badges, tags.

261 CONVEYOR SYSTEMS

Fuller Co.—Bulletin G-3, eight pages, pictures and describes pneumatic conveying systems built by the company for handling dry, pulverized and granular materials. Diagrams showing how systems work are included. Also illustrates and describes rotary compressors and vacuum pumps, inclined-grate coolers and Humboldt preheater for handling dry, granular materials.

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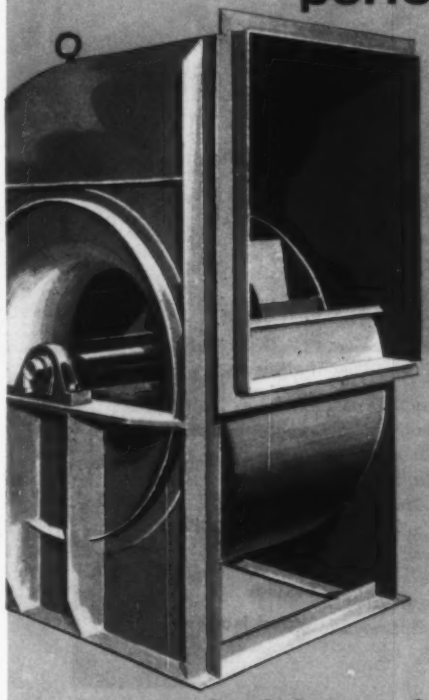

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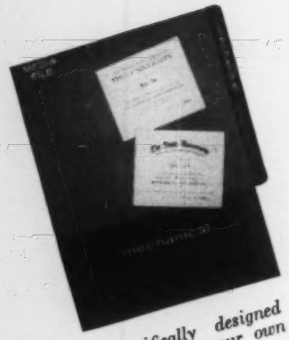

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YOUR New Catalogs GUIDE

262 OIL HEATERS

Bros Inc.—Four-page folder covers oil heaters applicable where temperatures to 500 F are required and operation at low pressures is desirable. The units operate at pressures below 15 psi.

263 PROPORTIONING PUMPS

Hills-McCanna Co.—A two-color, eight-page catalog, No. 604, covers details and specifications of the Model U and K mechanical and hydraulic drive metering and proportioning pumps, the Hills-McCannameter for precision pumping as low as 11 cc/min and the new Model 4411 chemical pump for systems requiring limited capacities.

264 BALL THRUST BEARINGS

Gwilliam Co.—Catalog No. 28 describes, illustrates and lists standard sizes of various types of ball thrust bearings, roller thrust bearings, and journal roller bearings.

265 DUST COLLECTION

Bubar Dust Systems, Inc.—Three types of dust collectors are shown in cutaway drawings, and applications of each are shown in an eight-page bulletin.

266 PLASTIC PIPE FITTINGS

Grinnell Co.—A 16-page catalog on corrosion resistant pipe fittings, flanges, valves and pipe in normal impact grade and high impact grade, rigid, unplasticized polyvinyl chloride shows characteristics, advantages and limitations. Listed are operating pressures, temperatures, applications, price comparisons, fabrication advice, installation and supporting recommendations, dimensions and weights.

267 RECORDING SYSTEMS

Consolidated Electrodynamics Corp.—A 24-page technical bulletin, No. 1561B, covers Data tape recording and playback systems, describes the airborne and ground components, furnishes highly-technical data on the recorder along with operating information and illustrates all integral parts. Also available is a four-page technical bulletin, No. 1576, describing a new magnetic tape recorder reproducer system, showing features, applications, description, and specifications for this ground unit.

268 DRILLING POWER

Alco Products, Inc.—Eight-page bulletin describes diesel-electric power package for oil well drilling. They are powered by Model 251-B diesel engines, and said to be the only completely self-contained units for drilling. No additional power source, either a-c or d-c, is required to operate any part of the rig.

269 BOILER SAFETY CONTROLS

McDonnell & Miller Inc.—Bulletin L-711 covers types low pressure boiler systems and safety controls and installations for each.

270 HEATING EQUIPMENT

Iron Fireman Mfg. Co.—A 60-page booklet covers engineering data on oil, gas and coal fired heating and power equipment. It is designed, not as a service manual, but to provide architects and engineers with information for better understanding the problems of fuel handling.

271 SOLID, TUBULAR EXTRUSIONS

Babcock & Wilcox Co., Tubular Products Div.—Bulletin TB-413 tells of the division's tubular and solid extruded shapes, lists extrudable steels, high alloys and nonferrous metals and briefly explains the process, size ranges, dimensional tolerances and advantages of the use of extruded solid or tubular sections.

272 WATER SOFTENERS

Permutit Co.—Bulletin 2386-B describes trouble caused by using hard water. Equipment specifications, operating characteristics, data on ion exchange resins and typical installation photographs are included.

273 STOOLS, CHAIRS

Cramer Posture Chair Co.—A brochure illustrates different models of stools and posture chairs. Engineering drawings and photographs show exclusive forward tilt, adjustable footring, finger-tip adjustments and foldaway back.

YOUR *New Catalogs* GUIDE

274 FIRED INDIRECT HEATERS

Brown Fintube Co.—Bulletin No. 551 covers the applications, advantages and types of fired indirect heaters for air, special atmospheres, corrosive and non-corrosive gases, thermal chemicals, circulating oils, asphalt, and for super heating vapors.

275 WELL SCREEN

Layne & Bowler, Inc.—Bulletin 900 covers improved Model 134 shutter screen for gravel wall wells. Specifications are included.

276 HEAVY DUTY COMPRESSORS

Pennsylvania Pump & Compressor Co.—Single stage, horizontal, water cooled, heavy duty air compressors in sizes from 10 to 125 hp and for pressures to 150 psig covered in Bulletin 201-E.

277 GLASS INSULATION

Pittsburgh Corning Corp.—Six specifications cover application of the firm's Foamglas insulation for industrial equipment and piping. Each booklet contains tables of suggested thicknesses of insulation to be applied, detail drawings of installation procedure, insulation supports.

278 FILTERS

Air-Maze Corp.—General catalog describes entire line of air filters and liquid filters, including oil bath air filters for engines, compressors, blowers, heating and ventilating filters and electrostatic precipitators, all metal, cleanable liquid strainers offering down to 10 micron filtration, odor eliminator panels, intake silencers, exhaust spark arresters.

279 PVC PLASTIC VALVES

Lunkenheimer Co.—Circular 601 describes new all-molded polyvinyl chloride valves, which are light weight and corrosion resistant. Molded in rigid form, the valve is said to be suitable for pressures up to 125 psi and temperatures to 150 F. Large, cutaway illustration shows design detail. The circular lists industrial fluids these valves handle, features of valves, and dimensions.

280 METAL STAMPING

Bossert Div., Rockwell Spring & Axle Co.—An eight-page booklet describes Bossert's engineering and product re-design service, and illustrates complete facilities for producing large or small stampings and assemblies in any metal or alloy. A special section is devoted to illustrations of typical stampings and welded components produced for metal products manufacturers.

281 CENTRALIZED LUBRICATION

Farval Corp.—An illustrated brochure, Bulletin No. 26-S, offers 20 pages of material relating to centralized systems of lubrication. The booklet discusses principles of operation, product advantages and system components.

282 PACKINGS, GASKETS

Crane Packing Co.—A 12-page booklet illustrates and describes the firm's Teflon mechanical and hydraulic packings, sheets, rods, tubing, tape, flexible bellows, gaskets, custom molded and machine parts, electrical and electronic parts.

283 LEASE AUTOMATION SYSTEMS

Black, Sivalls & Bryson, Inc.—Packaged lease automation from wellhead to pipeline provided by the firm's new Phanto-Matic lease system, is described in a 20-page catalog. The system offers fully automatic wellhead shut-in control, well test control, well flow control, tank switching, custody transfer, fluid metering, and lease safety controls.

284 ADJUSTABLE SPEED DRIVE

Dynamatic Div., Eaton Mfg. Co.—Bulletin FAS6 illustrates and describes the firm's fractional horsepower Ajusto-Spede drive. Fundamentals of operation, capacities, mechanical construction, optional features and controls are covered.

285 MOYNO PUMPS

Robbins & Myers, Inc.—An eight-page brochure describing the history and added benefits derived from use of the Moyno pump. Phases detailed about this "progressing cavity" pump includes its principle of operation, performance, construction, capacities, and speeds.

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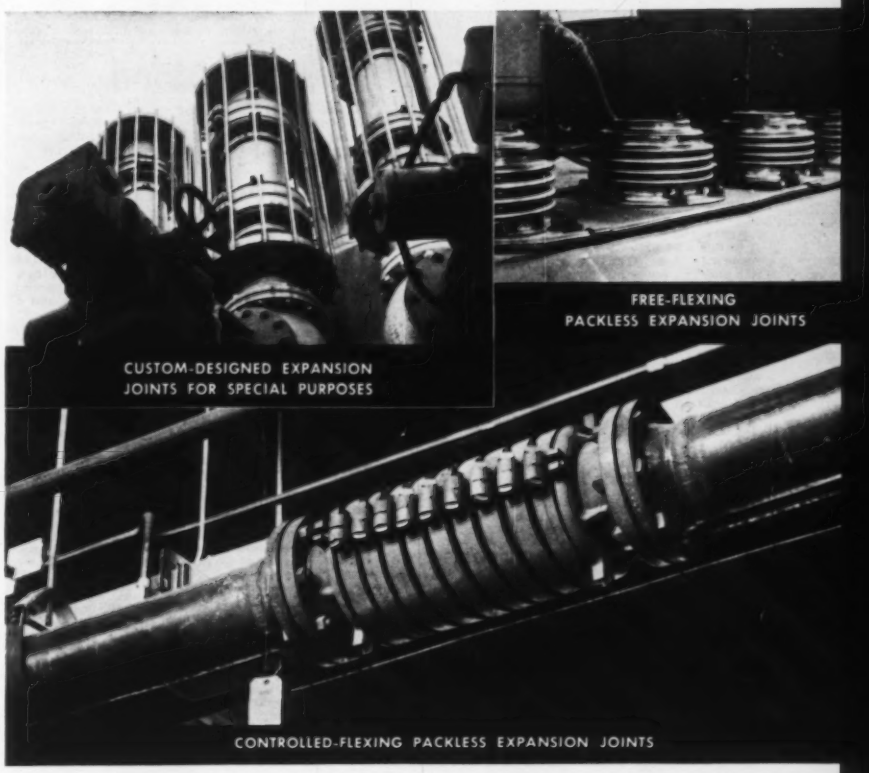
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New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

286 STEEL BOILERS

Pacific Steel Boiler Div., National-U.S. Radiator Corp.—A 24-page catalog, AP-364, features the entire line of Pacific Steel Boilers for medium to large size installations as well as SBI table 1 boilers for commercial applications are featured.

287 BALL BEARINGS

Federal Bearings Co.—Catalog D-1 contains 24 pages of dimensional tables for selection of ball bearings according to size, and assists in the identification of ball bearings for which a replacement is required. Both metric and inch measurements are shown. Catalog also includes interchange and conversion tables.

288 COMBINATION OIL-GAS BURNERS

Anthony Co.—Data Sheet BG-H describes Nebulyte combination oil-gas burner, and includes capacity table, selection chart graph, dimension drawings and typical layouts of burners and accessories. Also available are Data Sheets BA BD and BL covering low and high-range industrial oil burners and Bulletin 501 on a proportioning burner.

289 MULTI-V DRIVES

Worthington Corp.—A 100-page master engineering manual presents a scientific and simplified method for rating V-belts. Tables on drive selection contain nearly every possible stock sheave combination. Information on products and range of stock size sheaves with bore limitations is included.

290 STAINLESS STEEL

Sharon Steel Corp.—A 32-page catalog offers description, chemical composition, strength factors, physical properties and applications for stainless steels, including the 200,300 and 400 series. Forging ingots and rolled-in surface patterned stainless steels are included.

291 INDUSTRIAL PLASTICS

H. N. Hartwell & Son.—Catalogs and technical bulletins describe Boltaron 6200 corrosion resistant unplasticized polyvinyl chloride sheet, pipe, pipe fittings, valves, bars, blocks, and welding rod, as well as Boltaron 7200 modified high impact PVC sheet and pipe materials.

292 ULTRASONIC MACHINING

Sheffield Corp.—How to use ultrasonic energy to cut, drill, emboss, engrave, slice, and dice hard and brittle metals and nonmetals is shown in publication No. CAV 7-56. The 16-page illustrated booklet describes the ultrasonic machining process, shows examples of designs and forms machined in carbide, glass, germanium, ferrite and ceramic, and also includes specifications and machining capacities of ultrasonic machine tools.

293 BEARINGS, BUSHINGS

Cleveland Graphite Bronze Co., Div. Clevite Corp.—A 16-page catalog gives data on engineering, material analyses and applications of bearings, bushings, wear plates, thrust bearings.

294 DUST, FUME COLLECTORS

Northern Blower Co.—Bulletin 164 describes automatic bag type arresters, diagrams standard dimension factors and supplies table of dimensions and capacities. Separate additional bulletins contain similar data for standard bag type (not automatic), hydraulic type, centrifugal type, and portable dust collectors.

295 HYDRAULIC PRESSES

Lake Erie Machinery Corp.—Bulletin 1.1 describes hydraulic presses and die casting machines. It incorporates a comprehensive chart relating various types of presses to their production uses. Photos of representative presses and a selection chart are included.

296 VALVES, CONTROLS

Hays Mfg. Co.—A packet of data sheets covers the firm's lines of solenoid valves, controls, strainers and automatic interlocks. Specifications, dimensions and flow charts are given.

297 OPTICAL INSTRUMENTS

Bausch & Lomb Optical Co.—A booklet, "Industrial Optical Aids," contains information on an assortment of inexpensive precision optical instruments and suggests ways to use them to gain faster, easier, lower-cost production. Items discussed include magnifiers, microscopes, wide field tubes, macroscopes and comparators. Catalog D 1059.

298 HYDRAULIC CYLINDER

Hanna Engrg. Wks.—Four-page folder illustrates and describes a hydraulic cylinder designed specifically for spar mills. Design features are discussed and dimensions given in diagram form.

299 LAMINATED PLASTICS

Formica Corp.—New 20-page technical catalog, Formica-4, describing the four basic services offered by the firm to industrial users of laminated plastics. Included is information on copper clad laminates, laminated plastic sheet sizes, moldings, rods, tubes, post forming, fabricating—and special Formica NEMA and special grade charts and a comparator chart.

300 HARD CARBIDES

Kennametal, Inc.—A 44-page booklet describes basic design principles for use of hard carbides; methods of forming; methods of fastening carbides mechanically; and a general treatise of Kennametal and suggested fields of application.

301 GLASSED STEEL

Pfaudler Co., Div. of Pfaudler Permutit Inc.—Bulletin 928 illustrates and describes the corrosion resistance of glassed steel to acid solutions. Resistance charts of various nitric, acetic, sulphuric, hydrochloric and phosphoric acid solutions are included in the booklet.

302 IRON UNIONS

Dart Union Co.—Catalog B-51 provides descriptions and specifications on malleable iron unions and union fittings with bronze-to-bronze seats and in the all-iron construction. Pressure ratings are sizes $^1/_8$ through 2 in., 300 lb steam working pressure, sizes $2^1/_2$ through 4 in., 250 lb steam working pressure, all sizes 600 lb cold water, oil or gas pressure, non-shock.

303 SPEED CONTROL DRIVES

Clark Controller Co.—Bulletin 20,000 describes the company's packaged speed control drives which are said to incorporate into one package the elements of adjustable-voltage d-c drives. Included is a unit cabinet containing power conversion equipment and controls, one or more control stations, and drive motor or motors.

304 PUMPS AND AIR COMPRESSORS

Worthington Corp.—A 24-page brochure detailing information on Standard industrial pumps and air compressors. Also included is hydraulic data and descriptive material on Worthington steam, rotary, power, centrifugal, regenerative turbine and circulating pumps. Also included is compressed air data and material on Worthington air compressors.

305 GLASS FIBER INSULATION

L-O-F Glass Fibers Co.—Illustrated brochures outline advantages of both Microlite and Superfine glass fiber insulations, low-density resilient insulating materials with high thermal efficiency and round absorption characteristics. They are described as being resistant to heat, fire, moisture, and corrosion and the company recommends their use in applications where the greatest thermal and acoustical efficiency is desirable in the smallest space. Tables are included on thermal and acoustical performance.

306 HEAVY DUTY V-BELT

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Bulletin M210 describes a new Condor LS V-belt made for long center, heavy duty drives. The belt features a precision proportioned construction to eliminate V-belt whip and turn-over.

307 HYDRAULIC MULTIPRESS

Denison Engrg. Div., American Brake Shoe Co.—Catalog 120-D illustrates and describes the firm's hydraulic multipress in 10 sizes from 1 to 75 tons capacity. General specifications and diagrams are included for the various models and accessories.

308 COMBUSTION EQUIPMENT

Hauck Mfg. Co.—The Catalog 52 gives a condensed and pictorial review of oil and gas combustion equipment for production, construction, and maintenance applications in industry. The catalog has 12 pages and 80 illustrations.

309 DEMINERALIZATION

Graver Water Conditioning Co.—Bulletin WC-111A covers the application of demineralizers, their basic principles of operation and the chemistry of ion exchange resin. Information and charts on materials of construction and the design of component parts is included.

310 SPRING MATERIALS

Hunter Spring Co.—A 12-page booklet discusses pricing, quoting, tolerances, tangling, packaging, spring materials with cost comparisons, quality reporting.

311 ELECTRICAL CONTROL CABINETS

Industrial Equipment Co.—Brochure shows sizes and construction of metal cabinets for electrical and hydraulic control panels. Special types are also shown.

312 OIL AND GAS BURNERS

Ray Oil Burner Co.—A new illustrated 16-page catalog gives specifications and capacities of commercial and industrial gas, oil and combination gas-oil burners. It covers fully automatic, semi-automatic, and manually controlled horizontal rotary oil burners, gas burners, and combination gas-oil burners; commercial and domestic pressure-atomizing types for oil, gas, or combination gas-oil inshot gas burners; forced draft packaged burners. Tables and other technical data are included to aid in selection.

313 CHEMICAL PUMPS

Pacific Pumps, Inc., Div. of Dresser Industries, Inc.—Bulletin 137 illustrates and describes Type SVC pump, developed for efficient and economical transfer of hydrocarbons, chemical solutions, acids, and condensates in process installations. The water cooled, centrifugal pump has temperatures to 800 F, capacity from 15 to 3000 gpm at a working pressure of 600 psig, a differential head of 700 ft and speeds to 4000 rpm.

314 ROTARY SLITTING LINES

Yoder Co.—A 75-page handbook provides information on slitters and allied equipment. Basic data on design, selection and operation of slitting lines, and specifications of slitters, uncoilers, recoilers, coil cars, and scrap choppers are included.

315 MATERIALS HANDLING

Jeffrey Mfg. Co.—Catalog 911 offers a comprehensive study of the broad line of foundry equipment which Jeffery manufactures. Subdivided into four separate sections, the book contains detailed specifications and line drawings supplemented by pertinent data and installation photographs. A feature of the catalog is the new "package" sand handling system just recently introduced.

316 PIPING INSULATION MANUAL

American Gilsonite Co.—A 20-page booklet covers the methods of application of Gilsulate, a new insulation for hot underground pipes. It describes the three grades, how to determine ditch size for various pipes and types of soil, and gives sample problems.

317 STORAGE TANKS

W. E. Caldwell Co.—A 48-page catalog, No. 65, contains technical data, illustrations and price information covering metal and wood tanks with mechanical equipment and other accessories. Included are elevated and ground storage tanks, field erected, and shop build pressure and vented tanks.

YOUR

New Catalogs GUIDE

318 ELECTRIC HEATING UNITS

Edwin L. Wiegand Co.—Catalog 50 covers specifications, construction details, application data, and prices of their complete line of electric heating units. Models are available with strip, ring, tubular, and cartridge heating elements. Also described are immersion, circulation, radiant, and forced-air duct heaters. Charts and tables are provided.

319 FLEXIBLE COUPLINGS

Poole Foundry & Machine Co.—A 136-page manual illustrates, describes and gives engineering specification and lubrication data on flexible couplings.

320 AUTOMATIC CONTROLS

Mercoid Corp.—Catalog Number 858, a 60-page reference book for engineers, contains information on automatic controls for pressure, temperature, liquid level, and mechanical movement. Transformer-relays and mercury switches are also listed.

321 PLASTIC SHIMS, GASKETS

Chicago-Wilcox Mfg. Co.—Form 570 gives characteristics on plastic shims, gaskets, and shim stock. Data on color coding by thickness and results of testing the material is included.

322 SPECIAL PURPOSE STEEL

Crucible Steel Co. of America.—A 232-page catalog describes more than 700 products available from stock at warehouses throughout the country. The book index lists 16 categories, including high speed, tool, stainless, alloy and machinery, available in 16,000 grades and sizes. Estimating, conversions and weight tables are included.

323 TECHNICAL BOOKS FOR ENGINEERS

Ronald Press—Brochures containing detailed descriptions of current technical books on mechanics, engineering, aeronautics, industrial management, metallurgy, applied and physical sciences, etc. Practical reference works like the Ronald Handbooks, basic studies, and pioneering works on the latest engineering and scientific developments are included.

324 VERTICAL TURBINE PUMPS

Layne & Bowler, Inc.—A comprehensive book explains vertical turbine pumps. Included in the 72-page hard-bound book are graphic tables, photographs, drawings and charts.

325 CORRUGATED ROOFING, SIDING

Philip Carey Mfg. Co.—Form 6300 illustrates corrugated asbestos-cement roofing and siding composed of Portland cement and asbestos fibres combined under pressure to form a homogeneous, monolithic sheet. The material is highly resistant to fire, acid and alkali fumes, salt air, rot proof and rodent proof. It never needs painting, but can be painted. Because deep corrugations provide beautiful shadow effects, it is often used for decorative purposes.

326 STEAM TRAPS

Armstrong Machine Wks.—A 44-page manual on condensate drainage contains data on semi-steel and forged traps, discusses the fundamentals of good trapping, and deals with trap selection problems, installation, repair and trouble shooting.

327 POLYVINYL PRODUCTS

B. F. Goodrich Chemical Co.—A booklet gives properties and illustrates applications of Geon vinyl resins for industrial and consumer uses in extrusions, film and sheeting, molded products, expanded vinyls, coatings and rigid materials.

328 FOOD FREEZING, CHILLING

Niagara Blower Co.—Bulletin 105 describes the firm's method used for food freezing, chilling, and warehouse refrigeration on a large scale without frost or ice formation.

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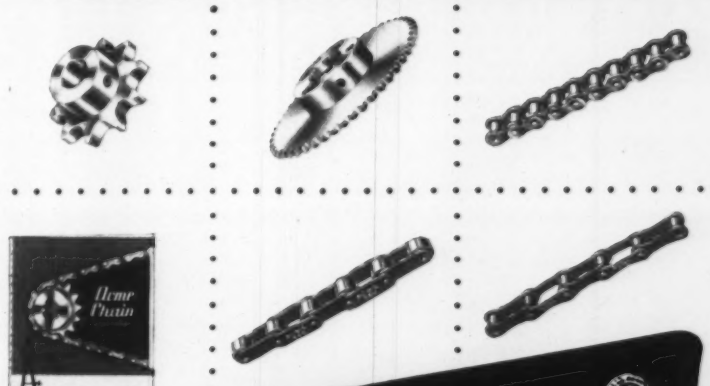

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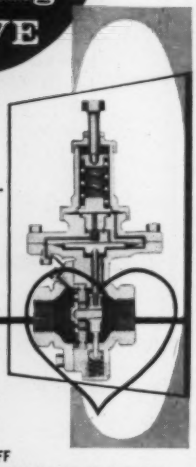

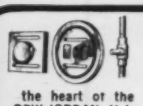

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LATEST INDUSTRIAL LITERATURE

329 CIRCULATING OIL SYSTEMS

Farval Corp.—Bulletin No. 70, an eight-page illustrated brochure, provides information on Lubrival, a new type of circulating oil system for presses and other semi-automatic or automatic production equipment. The booklet contains application photos, schematic drawings and description of components.

330 REDUCTION EQUIPMENT

American Pulverizer Co.—Literature describes reduction problems of various processing industries. Construction and operating features, specifications are fully discussed and illustrated. Bulletins are available on coal crushers, stone crushers, metal turnings crushers, plastics granulators, wood hogs.

331 AUTOMATIC MECHANICAL CLUTCHES

Mercury Clutch Div., Automatic Steel Products, Inc.—An eight-page folder gives specifications, applications and special data on the two general types of clutches for gasoline engines and electric motors. Also listed are representatives who are qualified to assist in the proper selection and application of the firm's clutches.

332 STREAMLINED BAFFLES

Engineer Co.—Bulletin BW-54 shows the design and describes the construction of streamlined baffles for many types of water tube boilers for various furnace designs and methods of firing.

333 BOILER SERVICE VALVES

Everlasting Valve Co.—Bulletin describes the Everlasting Quick-Opening and Slow-Opening Straightway Valves, Angle Valves, Y Valves, and Duplex Blow-Off Units, with specifications, materials of construction, and dimensions of each type. Illustrations include details of design, sectional and exploded views, and explanations of operation of the valves. A section of the bulletin also describes Everlasting Valves for fire protection.

334 CUSTOMIZED MOTORS

Jack & Heintz, Inc.—An eight-page booklet, "Design Your Product To Do a Job—Not to Fit a Motor," covers customized electric motors, and describes the firm's facilities for designing, testing, and producing special electric motors up to and including 3 hp.

335 LIQUID LEVEL GAGES

Jerguson Gage & Valve Co.—Condensed catalog No. 305 illustrates standard and special function gages and valves, giving dimensional drawings, construction features, pressure-temperature graphs and ratings, materials, and tables of sizes, specifications and standard and optional features. Illustrated with photographs and drawings.

336 CENTRIFUGAL PUMPS

Pacific Pumps, Inc.—"The Choice, Design, Characteristics and Maintenance of Centrifugal Pumps" is a reprint in booklet form of three published articles.

337 MECHANICAL-OPTICAL FACILITIES

Kollmorgen Optical Corp.—Bulletin 500 describes facilities for precision mechanical and optical manufacturing. It includes engineering and inspection equipment, plus narrative outlining company's activities in the fields of atomic energy, nuclear research and remote observation, with emphasis on industrial periscopes of which it is a prime supplier for government and commercial use.

338 POLYVINYL CHLORIDE PIPE

National Tube Div., U.S. Steel Corp.—Bulletin 24 gives properties and specifications of both high-impact and normal-impact polyvinyl chloride pipe. A section covers installation procedures. The chemical resistance of the plastic pipe is compared with pipe of other materials.

339 REFUSE INCINERATOR WALLS

Bernitz Furnace Appliance Co.—Bulletin B-58 describes silicon carbide air-cooled blocks for incinerator walls. The blocks are designed to improve combustion, insure long furnace wall life, and reduce maintenance and down time. The walls are claimed to remain free of slag and clinker build-up.

340 POWER SCREW DRIVES

Magna Driver Corp.—A 27-page catalog gives specifications, diagrams of various magnetic screw holding accessories for power drivers and nut setters. Also included are hand screw drivers, screw driver bits, and sockets.

341 TUBE EXPANDERS

Gustav Wiedeke Co.—Catalog 81 contains specifications on the firm's line of tube expanders and cutters. Included are tables of sizes, ordering information and a list of domestic and foreign distributor locations.

342 FILTERS, FILTER ELEMENTS

Cuno Engineering Corp.—Catalogs cover Micro-Klean replaceable filter elements, Flo-Klean automatic self-cleaning wire-wound filters, Poro-Klean porous stainless steel media for filtration, Micro-Klean filters for air line service, and Micro-Screen filter elements of reinforced screen mesh.

343 PACKAGED STEAM GENERATORS

Superior Combustion Industries, Inc.—Packaged water tube type D Superior steam generators with capacities to 50,000 lb of steam per hour are described in a 12-page bulletin.

344 SELF-LOCKING SCREWS

Standard Pressed Steel Co.—A 16-page booklet on self-locking socket head cap and set screws describes self-locking insert, gives specifications and performance data on material. Sizes, dimensions and packaging information is included.

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YOUR *New Catalogs* GUIDE

345 QUICK OPENING DOORS

Struthers Wells Corp.—Bulletin SW-553 covers quick opening doors for processing equipment. Automatic or semi-automatic in operation, the units are available in Ring-lok or Wedg-lok types, designed for vulcanizers, devulcanizers, impregnators, sterilizers, cement block curing vessels, ovens, and creosoting cylinders.

346 PUNCHES AND DIES

T. H. Lewthwaite Machine Co.—Catalog sheets illustrate and describe hand operated punches, cutters, and benders and list large, planned stock of punches and dies to fit most makes of punch presses. New, simplified system of decimal die marking is introduced with charts for determining correct clearance to allow for both type and thickness of metal being punched.

347 GAGES AND THERMOMETERS

Marsh Instrument Co.—Catalogs No. 76-G and 76-T describe in detail a wide line of industrial gages, needle valves, and thermometers. The catalogs are fully illustrated, including cut-away photographs and enlargements of internal parts. They cover also gage accessories, specifications including line drawings and dimensional tables, and templates covering every size and pattern.

348 STANDARD INDEXING MACHINE CHASSIS

Swanson-Erie Corp.—A six-page folder describes Swanson standard indexing machine chassis' and accessories. Outlined are some of the over 200 standard models to suit requirements for special purpose automatic machines. Data explains how these standard machine chassis' save valuable engineering time and cut building costs.

349 CARBON SPECIALTIES

Morganite, Inc.—A 12-page bulletin illustrates, describes and gives design data on carbon specialties in such applications as self-lubricating bearings, valves, slides, seal noses, gland rings, piston rings and vanes.

350 ROOF VENTILATORS

Clarage Fan Co.—Bulletin 550 covers the new Centrilator, centrifugal type power roof ventilator with Jet Siphon feature for stable, high efficiency and quiet operation. Capacities and dimensions shown for 10 standard sizes. Units are constructed for static pressures in 2 in., capacities to 26,400 cfm.

351 VALVE COMPARISON CHART

Ohio Injector Co.—Form 194R2 covers latest editions of new valve designs in the entire valve industry. Also listed is a valve trim comparison table.

352 CENTRIFUGAL PUMPS

Corley Co.—Eight-page bulletin describes centrifugal pumps said to eliminate seals, stuffing boxes, packings, base supports or any need of lubrication. The units, in Hasteloy C, 316 stainless, monel, aluminum, bronze or cast iron operate at heads to 31 ft, capacities to 100 gpm.

353 HEAT EXCHANGERS

Pfaudler Co., Div. of Pfaudler Permutit Inc.—Manual No. 949 illustrates and describes the firm's new standardized alloy designs of shell and tube equipment for application in the chemical and food industries. They may be used for: condensers, heat exchangers, heaters, evaporators, coolers, and reactors. Selection data, system diagrams, specifications, construction, installation.

354 MAGNETIC FRICTION CLUTCHES

Dynamatic Div., Eaton Mfg. Co.—New line of electromagnetic, friction-type, industrial clutches and brakes is described in Bulletin MF-1, which includes illustrations of the various types and combinations as well as the separately-mounted control system used with the Dyna-torQ line.

355 THERMOCOUPLE SYSTEM CALIBRATOR

Pace Engineering Co.—A manual gives the theory and operation of equipment for calibrating multichannel thermocouple recording systems. The calibrator is one in which the reference temperature and scale are established by injection of monitored voltages supplied by two mercury cells.

MECHANICAL DESIGN ENGINEERS

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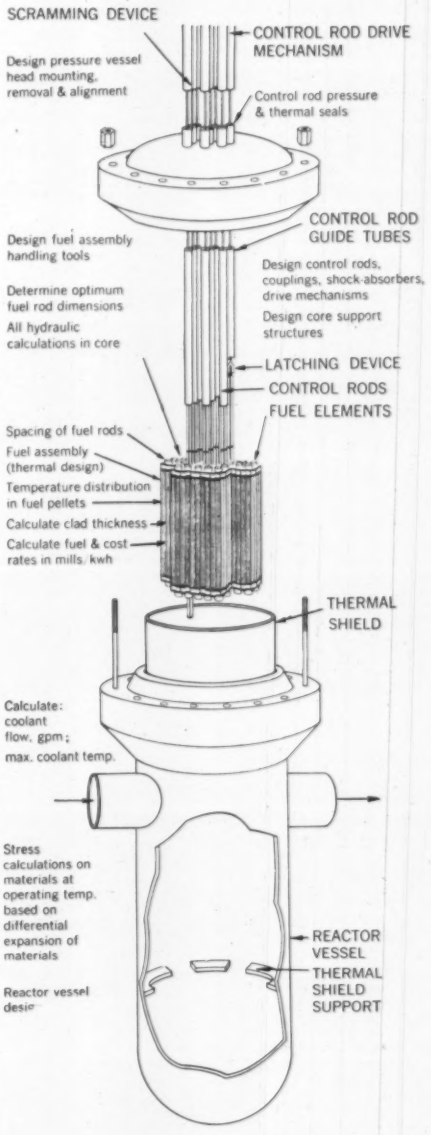
SCRAMMING DEVICE
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Design pressure vessel head mounting, removal & alignment
Control rod pressure & thermal seals
CONTROL ROD GUIDE TUBES
Design fuel assembly handling tools
Design control rods, couplings, shock-absorbers, drive mechanisms
Determine optimum fuel rod dimensions
Design core support structures
All hydraulic calculations in core
LATCHING DEVICE
CONTROL RODS
FUEL ELEMENTS
Spacing of fuel rods
Fuel assembly (thermal design)
Temperature distribution in fuel pellets
Calculate clad thickness
Calculate fuel & cost rates in mills/kwh
THERMAL SHIELD
Calculate: coolant flow, gpm; max. coolant temp.
Stress calculations on materials at operating temp. based on differential expansion of materials
Reactor vessel desig
REACTOR VESSEL
THERMAL SHIELD SUPPORT

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3. A 134-megawatt reactor for Yankee Atomic Electric Co.
4. A 134-megawatt atomic plant for Edison-Volta, Italy.
5. An 11.5-megawatt pressurized water reactor for Belgium.

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YOUR New Catalogs GUIDE

356 SCREW THREAD STANDARD

O-Vee Gauge Co.—"Screw Thread Standard H.28" has been revised and reprinted and issued Sept. 1957. New gaging requirements are discussed and described in a brochure, illustrated by diagrams.

357 RESERVOIRS, STANDPIPES

Koven Fabricators, Inc.—Bulletin 555 describes and illustrates steel reservoirs and standpipes designed to provide water storage from 50,000 to 2,500,000 gal. Bulletin 501 covers stress relieving, X-ray inspection, hot dip galvanizing.

358 VALVE SPECIFICATIONS

Cla-Val Co.—Catalog covers a standard line of ASA 125 and 250-lb class valves of the following types: vacuum relief, pressure relief, pressure reducing, pump control, rate of flow controller, check, remote control valves and controls, float solenoid and altitude. Catalog includes design and material specifications.

359 POWER ROOF VENTILATORS

Muckle Mfg. Co.—Eight-page bulletin covers four models of industrial type power roof ventilators from 200 through 17,000 cfm, propeller blade fan and backward curved wheel, direct driven and belted. Special finishes include galvanized, heresite, and zinc dust for gases. Models for vapor removal are included.

360 VACUUM PUMPS

Leiman Bros., Inc.—A 16-page catalog, No. 757, describes rotary positive air and vacuum pumps, gas boosters and air motors. Included are 2 and 4 wing types; fan-cooled, water-cooled and new radiator air-cooled models; motor driven units; direct-coupled and belt-driven models; integral pump and motor; automatically controlled tank units; accessories.

361 ALUMINUM CASTINGS

American Brake Shoe Co.—Brochure shows how to improve design, reduce weight in critical aircraft castings. New high-strength materials, Ductaluminum 356S and Ductaluminum 356T, are described. Improved casting reliability is said to cut shop rejects, reduces machining losses.

362 TIMING BELT

United States Rubber Co., Mechanical Goods Div.—A set of manuals illustrate and describe, with drive tables, the PowerGrip timing belt. This drive is said to assure tooth-grip precision, and for power transmission its steel cable tension member provides horsepower that ranges from $^1/_{100}$ to 600 and up, without stretch.

363 PILOT OPERATED TEMPERATURE REGULATORS

Spence Engineering Co.—Six-page Bulletin No. 1012 describes two new series of regulating valves with pilots for both fast and slow heating exchangers. Instantaneous heaters require the T134 or T124 pilot which handle heater pressures up to 50 psi. The T14 pilot is designed for slow acting heaters to take full line pressures. The T14D pilot is used when heater pressures must be limited. Selection tables and line drawings of typical applications are shown.

364 FANS, BLOWERS

Robinson Ventilating Co.—Bulletin 502 illustrates and describes fans, blowers, exhausters. Application photos are included, along with data on air properties, pressure and velocities.

365 LENSES, PRISMS

Bausch & Lomb Optical Co.—A 16-page catalog of optical parts contains information on ground glass, heat absorbing glass, retardation plates, and the firm's precision glass engraving and optical coating services. A new price list detailing up-to-date individual part prices, discount procedures, minimum ordering quantities, and terms of sale is included. Catalog L-117.

366 VIBRATION TEST MACHINES

All American Tool & Mfg. Co.—Catalog F describes five new models of vibration fatigue testing machines equipped with electronically controlled drive motors and automatic range selector for variable acceleration control. Units are said to provide infinite frequency control within the range of 5 to 100 cps, recorded on an electric tachometer.

YOUR

New Catalogs GUIDE

367 COPPER TUBING HANGERS

Grinell Co.—A 12-page catalog, CTH-56, covers hangers and supports for copper tubing. All hanger are copper plated and accurately sized to fit standard copper tubing. Data is also included on packaged quantities.

368 TWO-DRUM BOILERS

Erie City Iron Works—Catalog SB-58 covers VC two-drum boilers, said to provide high capacity in a compact design. The 12-page catalog describes improved features, design, construction, and application.

369 DRAFT GAGES, INSTRUMENTS

Ellison Draft Gage Co., Inc.—Bulletin 354-A gives a briefing on the entire line of the company's bell actuated and diafram actuated draft gages, inclined tube draft gages, pitot tubes, gas analyzers, steam calorimeters and other boiler room and laboratory gages and instruments.

370 STANDARD MOTORS

Sterling Electric Motors, Inc.—A 12-page colored brochure describes the firm's line of standard electric motors. The bulletin illustrates applications and contains selection information. Exclusive design advantages are described.

371 PACKAGED BOILER

Preferred Utilities Mfg. Corp.—A six-page booklet illustrates and describes the design, construction and application of "Thermopak" factory-assembled, automatic oil, gas or combination fuel burning system for old or new boilers. The system's components, accessories, and piping layouts are itemized.

372 HYDRAULIC TURBINES

James Leffel & Co.—Details on turbines that drive power generation and pumping units at the Bureau of Reclamation, Chandler power and pumping plant, are given in a 12-page bulletin, No. 1098-E. Descriptive literature on other recent turbine installations is also offered.

373 EXPANSION JOINT DESIGN GUIDE

Flexonics Corp.—A 28-page Flexon Expansion Joint Design Guide, Catalog 160, covers engineering application and selection data necessary to the proper solution of pipeline expansion problems. Features of the Flexon Design Guide include a discussion of the various types of expansion joints on the market, the many types of Flexon Expansion Joints available, and types of pipeline motion solved by expansion joints; also expansion joint design considerations, installation instructions, and selection data. The new line of Model H compensators is completely covered. The center spread of the catalog is devoted to a schematic piping layout illustrating various expansion joint applications and principles.

374 CENTRIFUGAL PUMPS

American-Marsh Pumps, Inc.—Six-page Bulletin 350 describes horizontal split case, single stage, double suction centrifugal pumps. Types HLM and HIM for wide range of capacity and head conditions. Large sectional view explains 18 important features. Specifications, performance data and dimension tables are included.

375 PROCESS EQUIPMENT

Pfaudler Co., Div. of Pfaudler Permutit Inc.—Bulletin 947 illustrates and describes glassed-steel, alloy reactors, columns, heat exchangers, condensers, evaporation equipment, storage, mixing and trailer tanks.

376 MECHANICAL SPRINGS

Associated Spring Corp.—An 84-page manual contains information on spring design, including forms for presenting all details about a particular design needed to prepare the specification. Principles of spring design and fundamental formulas for stress and deflection are included.

377 CENTER GUIDED CHECK VALVE

Miller Valve Co. Inc.—An eight-page bulletin illustrates and describes the Streamflow center guided check valve, said to be silent and shock-proof, and which can be installed vertically or horizontally. Specifications and dimensions are tabled.

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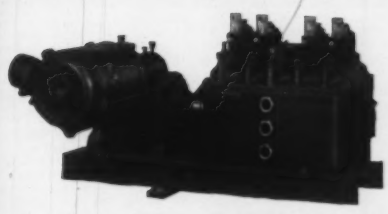

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LATEST INDUSTRIAL LITERATURE

378 TANK, VESSELS

Nooter Corp.—A 48-page Catalog No. 554 describes facilities, workscope, techniques in custom fabrication of steel and alloy plate for processing industries. Corrosion data tables for various metals are included.

379 HEAT ENCLOSURES

M. H. Detrick Co.—A 50-page illustrated booklet "Heat Enclosure Methods," outlines the development of furnaces and furnace construction. Suspended arch and wall construction and their application are shown for various types of units. Engineering graphs and tables are presented. Special booklets on incinerators, forge furnaces, open hearths, and industrial insulation are available.

380 CARBIDE TIPS

Firth Sterling Inc.—New 56-page catalog on carbide tips, tools, and inserts. A picture index identifies each product, and the pages have been die cut to expose the beginning of each section. A grade selection chart is included. Authorized distributors are listed.

381 VIBRATING FEEDERS

Carrier Conveyor Corp.—Natural frequency mechanical vibrating feeders are illustrated and described in Bulletin No. 1001. No complicated electrical equipment is used in these feeders which come in standard widths to 72 in. and lengths to 12 ft. Special high temperature models for 1800 F material are available. All models are available with fixed or variable feed rate drives.

382 BIN LEVEL CONTROLS

Bin-Dicator Co.—Catalog describes and illustrates bin level indicators including new Roto-Bin-Dicator and Bin-Flo aerator units. Dimensional drawings, mounting details, typical applications, wiring diagrams, and list of present users.

383 MISSILE GROUND-HANDLING AND LAUNCHING EQUIPMENT

Loewy-Hydropress Div. Baldwin-Lima-Hamilton—Bulletin 14.004 shows the firm's activities in modern rocketry and Loewy's successful debut with a test and flight-tiring installation for Martin's satellite vehicle "Vanguard." It also describes a giant Loewy ship motion simulator for the Navy Ballistic Missile program.

384 UNDERGROUND CONDUIT SYSTEMS

Stillwater Clay Products Co.—A four-page brochure describes vitrified clay conduit systems. This illustrated brochure describes the revolutionary new and exclusive Cert-A-Bar tunnel and Lock-A-Bar round systems and the many features of conduits, designed to assure permanent protection for piping. Information on conduit design, installation, engineering, insulation, waterproofing specifications and fittings also is included.

385 FLUID POWER DRIVES

Oilgear Co.—A 32-page bulletin, No. 10600, explains advantages, operation, and characteristics of Any-Speed drives. Performance curves and block diagrams on different types of rotary applications are included.

386 DIAPHRAGM VALVES

Hills-McCanna Co.—A 12-page catalog, No. 104, describes diaphragm valves in terms of their advantages, applications and specifications. The three basic types of valve operations are shown and dimensional specifications are given. Information is also included on plastic bodies.

387 HYDRAULIC PULSATION DAMPENER

Westinghouse Air Brake Co., Industrial Products Div.—A four-page catalog illustrates and describes a device that suppresses the pulsations and pressure surges which reciprocating pumps, centrifugal pumps and quick closing valves introduce into hydraulic systems.

388 FRACTIONAL HP MOTORS

Robbins & Myers, Inc.—A ten-page booklet describes its new line of Model R re-rated fractional horsepower motor available in ratings from 1/8 to 1 hp in polyphase, capacitor single phase, permanent split capacitor and (in the smaller ranges) split phase types. Totally-enclosed designs are included.

389 TORQUE CONVERTERS

National Supply Co.—Bulletin No. 468 describes single-stage torque converters for heavy industrial service, discussing background, design, types, sizes, circuits and applications. It also contains a capacity chart of the six sizes and 17 input ratings. Date sheets give application and dimension data of each of the six sizes, with performance curves, capacity chart, important features and typical torque converter arrangements.

390 OPTICAL TOOLING

Charles Bruning Co.—A 20-page illustrated booklet, explaining the theory, principles, and practice of the new technique of optical tooling. The booklet shows how optical tooling provides tolerances of .003 in. in 100 ft. It is claimed to offer easier construction, assembly, inspection, and unsurpassed dimensional control in erecting jigs, fixtures, and assembly structures.

391 V-BELT DRIVE

Raybestos-Manhattan, Inc., Manhattan Rubber Div.—Bulletin 6638C illustrates and describes the firm's Poly-V drive, a power transmission system that uses only two cross sections instead of five standard V-belts. The unit is said to eliminate problems of matching belts because it is a single unit across the full width of sheave.

392 LIQUID METERING EQUIPMENT

Black, Sivalls & Bryson, Inc.—The firm's line of fully automatic liquid metering equipment for handling lease produced liquids is outlined in a 24-page catalog. The line includes metering separators, chambers, tanks and test treaters. Any of the items may be used independently or as an integral part of the firm's lease system.

393 STOCK GEARS

American Stock Gear, Div. of Perfection Gear Co.—Catalog No. 360 contains information and engineering data covering brass, bronze, steel, semi-steel, cast iron, and nonmetallic gears in a range of 48 to 3 diametral pitch.

394 BOILER, TANK CONTROL

Commercial Shearing & Stamping Co.—Three catalogs are offered. Catalog P-2 covers products for boiler and tank manufacture; P-3, standard shapes which are available without tool and die charges; G-1, applications and advantages of stampings, forgings and assembled products.

395 PERMANENT MAGNETS

Indiana Steel Products Co.—Bulletin 17 illustrates and gives specifications on permanent magnet magnetizers. Bulletin 18 covers ceramic permanent magnets said to be adaptable where Alnico types are impractical.

396 DRAFTING EQUIPMENT

A. W. Faber-Castell Pencil Co.—The company offers three bulletins outlining some of their drafting materials. Described in detail are the Castell slide rules and scales as well as the Locktite Fleetline Holder, guaranteed dust-free because there is no sharpening or sanding. In addition Faber-Castell has available a pocket catalog for quick reference.

397 SILVER BRAZING OUTLETS

Bonney Forge & Tool Wks.—Brazolets used for silver brazing outlets to copper or brass pipe or tubing are described in this bulletin. The outlet portion is brazed or screwed. This construction is said to allow rapid installation of random length mains and subsequent attachment of outlets.

398 ROTARY MECHANICAL SEALS

Rotary Seal Div., Muskegon Piston Ring Co.—A 12-page brochure depicts the principle of retaining gases, oils, or other liquids under pressure and describes the basic component parts of seals for rotating shafts. Solutions to typical sealing problems are illustrated with an acetate overlay detailing seal construction.

399 TOOL STEELS

Crucible Steel Co. of America—A six-page index to Crucible tool steels and AISI type classifications. The cross index is an aid in making an accurate identification and selection of tool steels for specific jobs.

400 BOILERS

Brown Fintube Co.—Bulletin No. 554 illustrates and describes the construction, operation, controls of boilers in capacities of from 30 to 350 hp. Dimensions and specifications are tabled.

401 SHELL-ICE MAKERS

Frick Co.—Bulletin 54-C covers automatic shell-ice makers in nine sizes from 2 tons. Ice is frozen in thicknesses of 1/4 and 1/2 in. on the outside of stainless steel tubes.

402 BRONZE GLOBE VALVES

Lunkenheimer Co.—A four-page, three-color detailed circular 602-2 on the two pressure classes of LQ600 bronze globe valves, for a variety of services from normal to exceptionally severe, is offered. The two pressure classes—rated at 150 lb SP, 300 lb WOG, and 200 lb SP, 550 F, 400 lb WOG—are described, and all features of each are listed. ASTM, ASME and military specification numbers of alloy for bodies and bonnets are included.

403 SCREW PUMPS

Warren Pumps, Inc.—Bulletin No. 255 features twin screw pumps for oils and other noncorrosive liquids of wide viscosity range at discharge pressures up to 350 psig and capacities up to 550 gpm. Selection nomograph, outline dimensions, sectional drawings, and details of design and construction are provided.

404 COLD-ROLLED SPRING STEEL

Wallace Barnes Steel Div., Associated Spring Corp.—A 48-page brochure contains sizes, grades and hardness of cold-rolled spring steel and offers a general discussion of its essential qualities, what various grades are used for, how it is processed.

405 PRINTED CIRCUITRY GRID

Chart-Pak, Inc.—Literature describes a new grid on mylar film to aid in preparation of master drawings for printed circuitry. The firm's precision split tapes are mounted on the grid to reduce time and labor in making printed drawings.

406 CONTROL ADAPTERS

F. W. Stewart Corp.—A 16-page catalog describes various adapters for use in conjunction with flexible shafting. These adapters have proven to be most advantageous for control or transfer of action from the source of power to the control unit, the firm states. Adapters pertinent to aviation, automation, electronics, machinery, radio, and other fields are described.

407 HOT-DIP GALVANIZING

American Hot-Dip Galvanizers Assn.—A 16-page booklet outlines rust prevention in industrial and consumer products through the use of the hot-dip galvanizing process. Included are photographs of products made by the method, and illustrations of production and quality control. Chart compares method with other types of rust prevention.

408 FORCE CONTROL SWITCH

W. C. Dillon & Co.—Bulletin 49E covers model FCS-T-15 force control switch for tensile loads and model FCS-C-12 for compression loads. Dimensional diagrams and capacity tables are included for each unit.

409 AIR CONTROL VALVE

Hanna Engrg. Wks.—Catalog 262 gives data and dimensions on Flo-Pilot air control valves which have a small synthetic rubber boot that snaps into place around the valve stem to seal out dirt and abrasives. The same valve can be used either as two- or three-way.

410 GEAR REDUCERS

Winsmith, Inc.—Catalog SM-57 covers new hollow shaft worm gear type reducers. The eight-page booklet contains illustrations, sizes, dimensions and engineering data on both torque arm and flange type.

411 AIR CONDITIONING CONTROL

Niagara Blower Co.—Bulletin 122 describes and illustrates operation and suggests applications for an air conditioning method that controls humidity to 1 per cent RH and temperatures to 1 F.

YOUR

New Catalogs GUIDE

412 GROOVING TOOL

Waldes Kohinoor, Inc.—Catalog No. GT2-53 presents general information, engineering specifications, and manufacturing technical data for the Waldes Truarc grooving tool. The manual is illustrated with a number of tool setups and explains the functioning of the tool, particularly its economic performance on recessing operations. It also includes typical applications, dimensions and conversion tables, and ordering specifications.

413 DEAERATION

Cochrane Corp.—Publication No. 4650 explains in capsule form the fundamentals of deaeration and why it is necessary in water conditioning. The principles of operation as well as the advantages and application of the various methods of deaeration are discussed.

414 EXPANSION COMPENSATORS

Flexonics Corp.—Bulletin AIA No. 30-C-22 illustrates and describes expansion compensators for steam and hot water lines. Included is data on a high pressure type to 150 psi and a low pressure type to 40 psi.

415 CUSTOM GEARS

Cincinnati Gear Co.—Illustrated folder describes and shows examples of types of gears produced to individual specifications only for all types of machinery and products. Gear types listed include spur, helical, rack, worm, herringbone, bevel, spiral bevel, internal, sprocket, Zerol (R) bevel and Coniflex (R) bevel; also custom gear boxes.

416 OIL AND GAS BOILERS

S. T. Johnson Co., Mears, Kane, Ofeldt, Inc. Div.—Bulletins 2-L, 6-J, 7-D and 4-H cover line of gas, oil and combination oil and gas fired boilers from 1 to 30 hp, with the necessary automatic boiler feeds.

417 TURBINE SEAL

Koppers Company, Inc., Metal Products Div.—A 4-page folder on Huhn carbon rings for steam turbine applications discusses labyrinth, carbon garter spring ring and carbon ring sealing devices.

418 KILN INSTRUMENTATION

Leeds & Northrup Co.—A 16-page folder illustrates and describes instruments and controls for rotary kilns used in the manufacture of cement, lime and other non-metallic products. Installation photos are included.

419 AIR COMPRESSORS

Gardner-Denver Co.—An eight-page bulletin illustrates and describes carbon piston horizontal single-stage air compressors for oil-free air in the processing, chemical and plastic industries.

420 AUTOMATIC VALVES CONTROLLERS

A. W. Cash Co.—An eight-page catalog, No. S-730-1, illustrates and describes 42 items including pressure reducing, regulating, control, relief and back pressure valves, controllers, differential, temperature and combination regulators, governors, control systems.

421 ALLOY PROCESS PUMPS

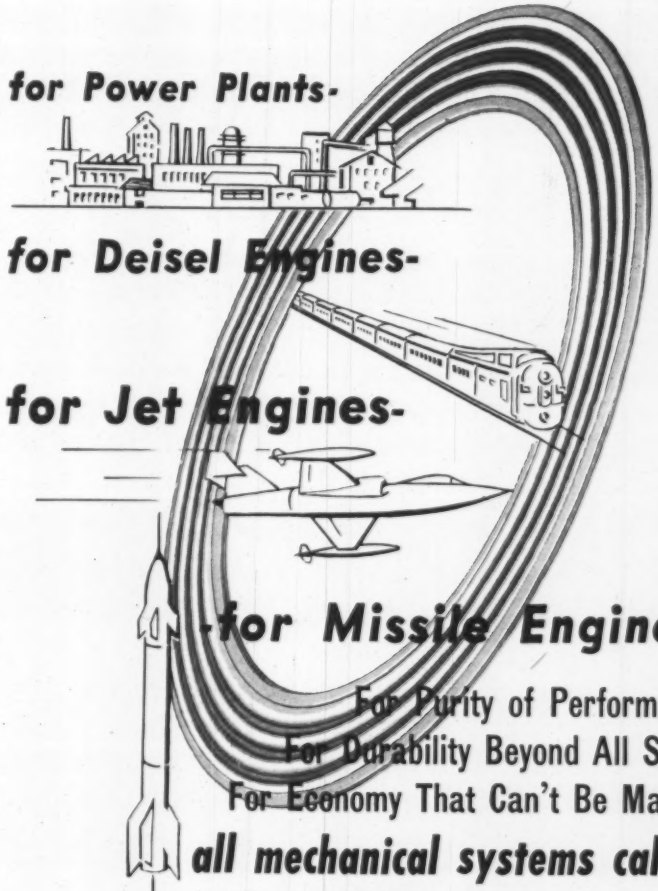
LaBour Co.,—Bulletin D-3 describes new centrifugal pumps with casing integral with suction and discharge fittings and supported directly on baseplate. New drive unit is designed to be installed without disturbing piping connections.

422 VIBRATING CONVEYORS

Carrier Conveyor Corp.—"Natural-Frequency" vibrating conveyor Bulletin No. 112, 12 pages, describes new application of scientific natural-frequency vibrating principle as applied to Carrier vibrating conveyors with great reduction in power requirements, double capacity, and significant savings in maintenance and down-time costs. Illustrates applications for detergent powder, crushed stone, foundry sand, castings and shakeout, spiral elevating for air cooling and other drying, heating, separating and blending processes; other uses and engineering data.

423 TOOL BITS

Firth Sterling Inc.—A catalog covers high speed steel tool bits. Typical analyses of five grades of high speed steel are included, with sizes, standard package quantities, weights per package, and prices. Authorized distributors are listed.



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424 STAINLESS STEELS

G. O. Carlson, Inc.—A four-page folder shows applications of stainless steel in plates, plate products, heads, rings, circles, forgings, flanges, bars, sheets. Products, equipment and services of the firm are discussed.

425 SELF-CLEANING CENTRIFUGE

Pfaudler Co., Div. of Pfaudler Permutit Inc.—Bulletin 946 presents information on its Titan superjector, an automatic self-cleaning centrifuge. Engineering information, specifications and application data are given, along with details on the operation of the unit.

426 SPRING DESIGN

Associated Spring Corp.—The fundamentals of spring design are set forth in an eight-page brochure. The brochure contains the basic stress and deflection formulas, the commonly used spring materials, typical applications, and certain limitations of each of the various types of springs. A tabulation of tensile, torsional and other physical properties of the commonly used spring materials, and notes on the process of manufacture and the chief uses of each is included.

427 VALVELESS FILTER

Permutit Co.—Bulletin No. 4351 describes the company's automatic gravity sand filter for municipal or industrial water treatment. The unit uses no valves, pumps, or flow controllers, and is said to cost less than conventional manual filters, reduce costs of installation, operation, maintenance and expansion, and produce uniform high-quality effluent. Sizes up to 400 gpm are available.

428 HEAT EXCHANGERS

Yates-American Machine Co.—Brochure HT-1A describes basic sizes of single, two- and four-pass fixed bundle heat exchangers data giving practical flow ranges and heat transfer rates. Brochure HT-5 describes construction details, sizes, and dimensions of steel shell removable bundle heat exchangers.

429 BOILER-FEED PUMPS

Worthington Corp.—Bulletin W-318-B23 illustrates and describes types UNB and UB-12 two-stage centrifugal boiler-feed pumps in capacities to 2500 gpm, heads to 900 ft. Cross sections of each type are shown, along with dimension diagrams.

430 WELD TUBE MILLS

Yoder Co.—A 64-page handbook describes the use of modern tube mills in the manufacture of pipe and tube. A description of the electric-weld process and photos, drawings and charts on the operation, capacities, and applications of various mills are included.

431 BOILERS, BURNERS

American-Standard, Kewanee Boiler Div.—Loose-leaf binder with separate sheets for each series of boilers and boiler-burner package units available includes cutaway drawings, descriptions, specification data and dimensions, and sample specifications. Residential, firebox, and scotch-type boilers are covered, ranging to 651 hp.

432 PORTABLE CRANE

Star Machine & Tool Co.—Literature describes a new portable "Little Oscar" hydro-lift crane with 1000-lb capacity and lifting range from 16 in. to more than 10 ft. The unit is 33 in. wide, giving it accessibility through standard door openings.

433 POWDER LANCING

Linde Co., Div. of Union Carbide Corp.—Eight-page folder describes a new tool capable of slicing through concrete of any thickness. Accurate control of intense heat is said to be the key to the operation of the new lance. The origin principle and scope of the powder-lancing process is outlined and discussed. Applications in steel mills, foundries, and on constructed and demolition jobs are illustrated and described.

434 MOTORS, GENERATORS

Marathon Electric Mfg. Corp.—Six-page bulletin illustrates and describes d-c motors and generators in frames 180 through 580. General construction features are shown, along with diagrams and tables of dimensions. The motors range from $\frac{1}{2}$ to 2500 hp, and the generators from $\frac{1}{2}$ to 2000 kw.

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Midwest Piping at Kyger Creek plant which has a capacity of 1,075,000 kw and is the largest power plant piping contract (combining fabrication and erection) ever performed by a single contractor.

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Before a construction job is placed in the Midwest shops for fabrication, experienced engineers prepare Field Erection Sketches dividing each line into a series of subassemblies. These Sketches minimize and simplify the field welding . . . the difficult work is done in our well-equipped shops. They also disclose any discrepancies before fabrication instead of during erection. All erection planning has been done by our engineering staff . . . which reduces field thinking and eliminates guesswork. Erection is from these sketches instead of from the design engineers drawings . . . this speeds up the work and results in a real cost saving and earlier completion of the job.

The next time you have a piping job, you'll find it profitable to call in Midwest.

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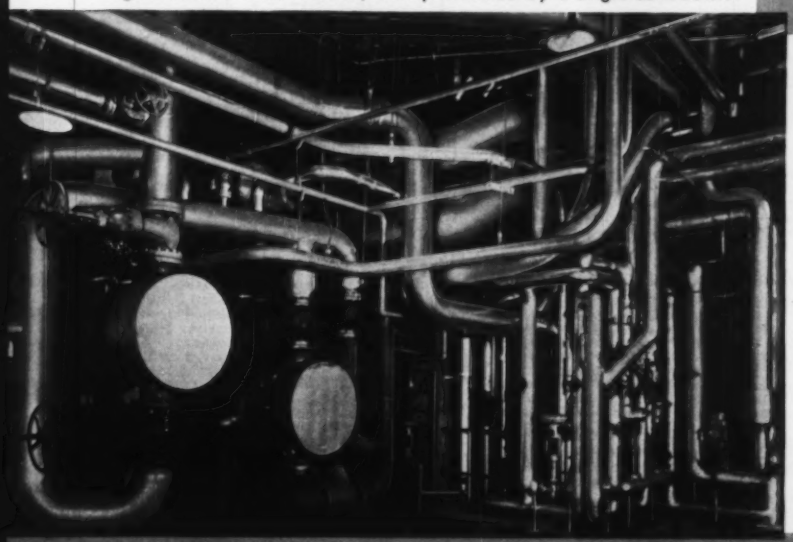

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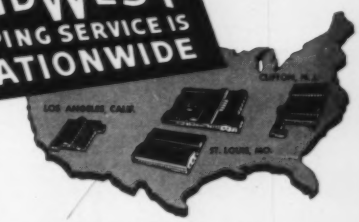

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435 CONSTANT TEMPERATURE PUMPS

Dean Brothers Pumps Inc.—Circular 195 describes new line of standard constant temperature pumps, Types CT-C and CT-R, for maintaining process temperatures when pumping of liquids which congeal, solidify or crystallize with loss of heat. Sectional views illustrate two methods of applying heat to pump: tracing and jacketing.

436 PROCESS CONTROL

Swartwout Co.—Bulletin describes electronic control and instrumentation for processing, power generation (including atomic energy), testing, research, and development. Principles of electronic transmission and control are discussed together with benefits, i.e., zero transmission lag, zero hysteresis and infinite resolution by continuous (stepless) modulation.

437 COMBUSTION ANALYZER

Bailey Meter Co.—Instantaneous analysis of exit gases from all types of boiler and industrial furnaces is said to be accomplished by portable Heat Prover combustion analyzer described in Product Specification E65-5. Illustrated is catalytic combustion principle by which per cent by volume of oxygen and combustibles present in a gas sample measured and indicated.

438 MARINE LOADING ARM

Chiksan Co.—Bulletin illustrates in detail features of a marine loading arm, operated by hydraulic controls. Arms of the unit swivel out from rest to hookup position in one and a half minutes. It operates with fluids from −60 to 225 F, and is currently available with arms of 6, 8, 10, 12, and 16-in. diameters.

439 ROLL FORMED SHAPES

Roll Formed Products Co.—A 26-page catalog covers the production of roll formed shapes. Processes shown include notching, punching and cutting to length of special shapes in one continuous operation. Also included are drawings and dimensions of more than 100 simple and complex shapes.

440 SQUARE HEAD CYLINDERS

Anker-Holth Div., Wellman Engrg. Co.—A 30-page data bulletin gives engineering specifications, ordering information for recently-introduced square head hydraulic cylinder line. Of tie-rod construction, line is rated for 2000 psi working pressures, up to 3000 psi in nonshock service. All mountings are available, standard bores range from $1^1/_2$ through 12 in. Standardized mountings are said to provide complete interchangeability with most makes of square head cylinders.

441 ELECTRONIC DATA PROCESSING

ElectroData Div., Burroughs Corp.—Eight-page Brochure No. 5220, describes latest electronic computing system designed for engineering, scientific and commercial applications. Details are given on speeds, programming, expandability, and filing capacities. Magnetic tape, paper tape, and punched card facilities available with this medium-price digital system are summarized.

442 METAL HOSE

Atlantic Metal Hose Co.—Bulletin 500-A contains descriptions and illustrations of high pressure hose made of heavy bronze or galvanized steel strip, air jacketed hose for diesel exhaust, conveyor hose for ventilating and exhausting. Bulletin 21-A covers flexible stainless steel hose.

443 PNEUMATIC CONVEYORS

National Conveyors Co.—Catalog P-56 shows uses of pneumatic conveyors for ash removal in steam plants; collection, processing and reclamation of cutting oils, chips, and borings in the metal working industry; and the handling of dry, pulverized or granular materials in other industry.

444 TRANSDUCERS

Consolidated Electrodynamics Corp.—A 32-page folder, No. 1552, on transducers and associated equipment, illustrates and describes vibration pickups, velocity pickups, torsiographs, pressure pickups, dynamic pressure pickups, accessories, suggested handling and mounting methods, pressure-conversion table and other data.

445 MULTIPORT VALVE

Hugerford & Terry, Inc.—A 16-page bulletin contains information and photographs of a poppet type multiport valve designed to operate water filters, zeolite water softeners, demineralizing equipment and other water conditioning equipment. The units work manually, semi-automatically or fully automatically.

446 GAGE LABORATORY

Sheffield Corp.—Tips on setting up a gage laboratory for precise dimensional control over tools and gages used in close-tolerance production and the precision measurement services available from the Eli Whitney Metrology Laboratory including certified gage block calibration, roundness measurement, and absolute and comparative interferometry are included in Publication No. IN-1-57.

447 STEREOMICROSCOPES

Bausch & Lomb—A catalog discusses principles and equipment used in connection with stereomicroscopy. A guide to the selection of stereomicroscopes and accessories is included, along with reproductions of specimens seen through this medium. Catalog D-15.

448 NAMEPLATE MARKING

Jas. H. Matthews & Co.—An eight-page bulletin illustrates and describes nameplate marking equipment from steel hand stamps to production machines.

449 MAGNETS, CORES

Indiana Steel Products Co.—Catalog 11 covers various types of Alnico permanent magnets. Catalog 14-A illustrates and describes the company's one-piece wound cores for transformers.

450 CHIMNEY DESIGN, MAINTENANCE

Consolidated Chimney Co.—Booklet illustrates and describes design, building, maintenance, and repair of chimneys. Included is design data, how to determine chimney size, standard specifiations for radial brick and reinforced concrete chimneys, information on special acid proof and high temperature linings, and installation of aviation obstruction lights and lightning rods.

451 COOLANT, CIRCULATING PUMPS

Graymills Corp.—Literature describes centrifugal and gear type coolant systems, complete with tanks and coolant pumps, ranging from $^1/_{25}$ to 1 hp. It tells how to select the right size and type of pumping unit for the machine tool, and lists information on mist coolant systems and Stocklube systems for automatic pressure lubrication of stock in metal forming and stamping operations.

452 GAS TURBINE ENGINES

Lycoming Div., Avco Mfg. Corp.—A brochure contains description and analysis of new lightweight gas turbine engines for aviation, marine, and industrial fields. Engine specifications, typical installations of T53 are set forth. Maintenance, production costs, and control features are covered.

453 METER TESTING

Hydraulic Products Co.—Bulletin is illustrated with installation photographs of air-water testing of gas meters ranging from five to 25c by an air-mechanical lifting and depressing device providing multiple loading.

454 HEAT EXCHANGERS

American-Standard, Ross Heat Exchanger Div.—Bulletin 1.1K6 describes expanded, redesigned line of standardized, pre-engineered Type BCF exchangers. New features include baffles with flanged lip at tube holes and outer edge for improved thermal characteristics; movable feet; corrosion-resistant copper alloy core assembly; and cast iron bonnets. Specifications detail 46 stocked sizes in one, two and four-pass designs.

455 AIR COCKS

Westinghouse Air Brake Co., Industrial Products Div.—A four-page datalog illustrates and describes plug type and diaphragm type two and three-way cut-out cocks for pneumatic systems.

456 LOCKING RING

Rosan, Inc.—Literature describes the firm's positive lock for steel inserts or studs in aluminum or magnesium alloys and other threaded fasteners and materials. No oversizes are required for replacements, the firm states.

457 AIR CONDITIONING MOTOR PUMPS

Ingersoll-Rand—Form 7473 describes motor pumps of the KRVS-KRVSA line. They range from $^1/_2$ to $7^1/_2$ hp and are built for air conditioning, refrigeration, and coolant circulation work. The centrifugal units have cast bronze impellers which run directly off short motor-shaft extensions of NEMA frame motors. The eight-page booklet gives performance curves, along with data on dimensions and a work sheet for pump selection.

458 CONDUIT SYSTEM

Stillwater Clay Products Co.—Newest development in underground piping layouts, the "one over one Cert-A-Bar conduit system" is described in a one-page, illustrated information sheet. Advantages of this system in steam and condensate systems, and in high-temperature water systems are listed and explained.

459 CONTROLLED-AIR-DEVICES

Bellows Co.—Bulletins BM-25 and ML-3 illustrate and explain air motors and the choice of built-in valves and auxiliary hydraulic controls available for them. Bulletin ML-3 also describes the basic types of complete-work-units, such as power feeds, work feed tables, drilling units. Both booklets contain application photographs.

460 VALVES

Ledeen Mfg. Co.—A 16-page bulletin illustrates and describes the company's line of hand, foot, power and solenoid operated valves, air, oil, gas or water powered. Bulletin gives operating and flow cycles, dimensions and weights. Cirucit diagrams, parts and accessories are included.

461 SPRING WASHERS

Associated Spring Corp.—A six-page brochure describes new compact energy "cartridges"—which consist of pre-assembled stacks of multiple Belleville spring washers held together by pins or rivets passing through the washers at or near their neutral axis. Exploded views show how the washers are assembled, and schematic drawings illustrate several typical applications for the cartridges.

462 TECHNICAL BOOKS AND PAPERS

The American Society of Mechanical Engineers—A 20-page catalog describing current books, standards, codes, research reports and periodicals published by the Society and a listing of available technical papers.

463 STAINLESS PIPE WELDING

Arcos Corp.—How to make the first, or root pass, in welding stainless or alloy pipe, welding from one side only is the subject of an 11-page bulletin. The use of a specially designed consumable insert to produce a sound weld, crevice free, with a flat contour inside the pipe, is described.

464 AIRSTREAM CONVEYORS

Dracco Div., Fuller Co.—A 32-page bulletin, No. 530, contains data and 70 illustrations and diagrams explaining operation, applications, and advantages of air conveying. Practical solutions to handling problems, including automated systems, are given.

465 PURIFIERS, MIST EXTRACTORS, SCRUBBERS, SEPARATORS

V. D. Anderson Co.—Bulletin No. 801 itemizes principal applications of purifiers which remove liquid, solid and dust entrainment from gases and vapors. Contains buying information on internal, receiver and line type separators, mist extractors, and scrubbers. Also describes Anderson's new Quik-Flex thermostatic steam traps as well as Super-Silvertop and Heat-Kwik steam traps and Anderson strainer and float traps.

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466 CLUTCHES, COUPLINGS

Hilliard Corp.—Catalog MP-5 lists and illustrates a line of industrial clutches and couplings including slip clutch, over-running clutch, single revolution clutch, and automatic centrifugal coupling. Brief description of operation is a guide to suggested applications of each item.

467 ALUMINUM CASTINGS

Morris Bean & Co.—Booklet on the Antioch Process offers a brief description of the process used currently in the production of aluminum castings weighing up to 2000 lb and up to 10 ft in diameter. Loose specification sheets covering applications in aircraft, missile, electronic, and fluid flow fields are available.

468 CYLINDERS, VALVES

Pathon Mfg. Co.—Bulletin 22A illustrates and describes oil hydraulic cylinders and valves. Included is information on rams, mounting brackets, and various types of cylinders and valves.

469 REFINERY PUMPS

Dean Brothers Pumps Inc.—Circular 201 describes new line of heavy duty centrifugal pumps for refinery and process service with top suction and discharge nozzles. Built to API and major oil company specifications, the units have capacities up to 1000 gpm. Pump sizes, mechanical design specifications and sectional view with parts list are included.

470 EFFECTS OF CHECK VALVES IN OVERCOMING WATER HAMMER

William Gauge Co.—The cause, effect, and control of water hammer in piping systems are considered in an 8-page bulletin. After describing water hammer in nontechnical terms, the brochure indicates its potential damage to piping, instruments, and other parts of water systems, and considers methods of controlling it.

471 WELDING FITTINGS

Tube Turns—Bulletin TT867 gives specifications and allowable working pressures for carbon steel light weight welding fittings from 4 through 24 in. Its economies are described as lower material-cost, labor saving, and increased efficiency.

472 SHEET METAL FASTENERS

Rosan, Inc.—Literature covers a press-nut sheet metal fastener that locks both axially and radially and will develop full strength of mating bolt in most materials. It is available in stainless steel or Ledloy material; internal thread sizes are No. 2 through 1/4, with or without internal thread locking feature.

473 BLOWERS, EXHAUSTERS

Miehle-Dexter Div.—Six-page folder on 3-lobe rotary positive industrial blowers and exhausters covers advantages over conventional 2-lobe blowers in pressure range, size, weight, cost, and service. Operating data, capacity curves, and typical applications, including use in pneumatic conveying, are given for 24 production models.

474 SPRINGS, WIRE FORMS

Dudek & Bock Spring Mfg. Co.—Brochure contains charts giving tips and methods for specifying and ordering springs and wire forms.

475 ASBESTOS-CEMENT BOARD

Philip Carey Mfg. Co.—Frorm 6285 describes asbestos-cement board for exterior walls, partitions, linings, utility structures. The material is not affected by most acids, alkalis, fumes, heat, cold, weather, salt air. It is vermin and rodent proof, will not rot, rust or corrode, and needs no paint or protective coating. It can be painted for decorative purposes. Suitable for continuous temperatures up to 600 F.

476 REMOTE CONTROL SYSTEM

S. Morgan Smith Co.—Catalog 164 covers a new packaged remote control system in which a positioner "package" incorporates all the necessary components in one standard unit for the control and positioning of any of the firm's valves. It may be controlled by liquid level, pressure, or by a remote manual control unit. The firm also offers a package of a Rotovalve with a standard hydraulic system and automatic controls for pump check service.

477 FLUID FILTERS, STRAINERS

Ronningen-Petter Co.—Bulletin 45778 illustrates and describes fluid filters and strainers for hot or cold water, oils, chemicals, beverages to 3300 gpm. The units are available in bronze, stainless steel, aluminum, iron, steel.

478 ALUMINUM FABRICATING

Aluminum Co. of America—Form 10984 illustrates and describes facilities for fabricating aluminum products. Rolling, brake forming, bending, spinning, and welding are shown, along with representative products.

479 SPRAY NOZZLES

Spraying Systems Co.—Spray nozzle reference catalog has 48 pages of specification and performance data. Listed are standard spray nozzles giving capacities and spray angles for standard industrial pressure ranges. Nozzles described include those producing full cone, hollow cone, square spray and flat spray patterns.

480 CORROSION RESISTANT FASTENINGS

H. M. Harper Co.—An 84-page catalog gives prices and descriptions of nonferrous and stainless steel bolts, nuts, screws, rivets, and washers. Included are corrosion resistant fastenings of brass, Navy bronze, silicon bronze, copper, nickel, monel, aluminum.

481 GATES

S. Morgan Smith Co.—Water control gates are described in Bulletin 163. This 16-page technical bulletin outlines the several basic types of gates and their applications. Discharge curves are shown for preliminary sizing, and general specifications are included. Sectional drawings, standard dimensions, and field photographs provide information on design characteristics and general construction.

482 THERMOCOUPLE TABLES

Pace Engineering Co.—A series of tables are available for use with the heated type of thermocouple reference junction in industrial and laboratory installations. A 150 F reference temperature is used. Copper, chromel, and iron types are covered.

483 INDUSTRIAL FILTERS

Sparkler Mfg. Co.—Bulletin 2202 includes condensed engineering data, capacity tables, specifications on water filters with capacities to 5,000,000 gpm, heavy duty filters for products with a high percentage of solids and filters for fine filtration.

484 HOLLOW FORGINGS

Babcock & Wilcox Co.—Bulletin S-16C gives specifications, surface finishes, materials reference tables, and shows production and finished products of hollow forgings.

485 SOLENOID VALVES

Ruggles-Klingemann Mfg. Co.—Revised Catalog E on electrically operated valves includes standard solenoid valves with improved features. Solenoid trip valves are now available with explosion proof solenoid enclosures. New additions are free handle solenoid trip valves, motor operated valve and epichron control switches.

486 WORM GEAR JACKS

Duff-Norton Co.—Eight-page bulletin, No. AD-66, describes how two or more jacks can be tied together in a jacking arrangement by means of couplings, shafting and mitre gear boxes. All jacks will raise and lower in unison and arrangements can be motor driven. Jack capacities range from two to one hundred tons. Specifications and dimension drawings are included.

487 TUBING BENDER

Paul Machine Tool Div., Paul Machine Tool Die Wks.—Literature describes Model S serpentine bender for bending thin wall copper and aluminum tubing up to 180 deg at speeds that range up to 900 bends an hour.

NEW CATALOG AVAILABLE

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BULLETIN No. 31

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CERTAIN distinctive characteristics and features make Barco Flexible Ball Joints particularly well-suited for solving many present-day plant piping design problems, especially for *Steam Service:*

1. **Ability to handle compound movement (where twisting is combined with thermal expansion and contraction).**
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3. **No heavy pipe anchoring required. No "end thrust" developed under pressure. Minimum space needed for installation.**
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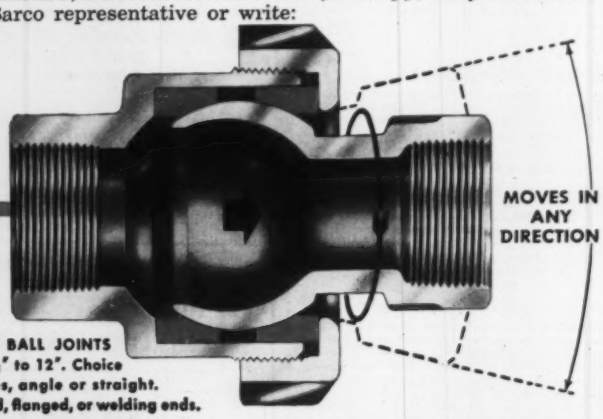
New Bulletin No. 31 contains interesting diagrams showing how to solve many common pipe expansion problems EASILY, ECONOMICALLY. *Ask for a copy;* see your nearest Barco representative or write:



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Sizes ½" to 12". Choice of styles, angle or straight. Screwed, flanged, or welding ends.

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BARCO ANNIVERSARY 50TH

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
In Canada: The Holden Co., Ltd., Montreal

488 CENTRIFUGAL FANS

Ilg Electric Ventilating Co.—Type BC centrifugal fans with airfoil blades, aluminum sides and scroll, in both direct-connected and belted models for ventilating and heating equipment are illustrated and described in eight-page Bulletin S316. Performance, dimensions and capacities are given for each type with detailed drawings.

489 OIL FREE COMPRESSORS

Ingersoll-Rand—Form 1552 lists three models of Type-30 oil-free air compressors with nonlubricated cylinders: the Model N, the 23 ANL and the 235 HNL. They are designed for instrument control or applications where oil in the discharge air can't be tolerated. The units, which cover a ½ to 3 hp range, use carbon piston rings, making oil lubrication unnecessary in the cylinders.

490 GASKETS

Garlock Packing Co.—Bulletin AD-104 describes the firm's Guardian spiral wound metal gaskets. The bulletin details features and design factors of the metal gaskets as well as the types available for specific applications.

491 RING-LOCKED FASTENERS

Rosan, Inc.—Literature describes the firm's locking ring principle for positive lock for steel inserts or studs in aluminum or magnesium alloys and other threaded fasteners and materials.

492 WATER CONDITIONING

Permutit Co.—A 12-page bulletin, No. 4433, is a general discussion of the major types of water treating equipment—filters, zeolite softeners, precipitators, chemical feeders, demineralizers. Each equipment type is illustrated and discussed briefly. Water impurities and their general methods of removal are tabulated and typical water-treatment systems for municipalities, utilities, and industries are illustrated.

493 FLEXIBLE CONNECTORS

Cobra Metal Hose—Forms 1K-1 and 1K-3 give data and prices on bronze heavy duty flexible connectors for gases, liquids, and semi-solids. Flexible pump connectors, nipples and noise absorbers are included.

494 SPRING PINS

C. E. M. Co.—Catalog lists prices, dimensions, technical information on heavy, medium, and light duty Spirol spring pins in carbon steel, chrome, stainless steel, and nickel stainless steel. Typical applications are illustrated.

495 VENTURI TUBES

Builders-Providence, Inc., Div. B-I-F Industries, Inc.—Design features, comprehensive dimensional data, capacity tables, recovery tables on venturi tubes are included in Bulletin 110-N1A.

496 GASKET MATERIAL, TEFLON

American Felt Co.—Literature describes the chemical and physical properties of Vistex with Teflon, a gasketing material. It has a tensile strength of 5000 psi, good cutting properties and is designed to resist fraying.

497 SEALS

Sealol Corp.—"How to Determine if Mechanical Seals Will Save You Money" is a four-page comparative cost analysis form that compares specific packing versus mechanical seal costs.

498 ROTOSTOKERS

Detroit Stoker Co.—RotoStoker Type CC (continuous cleaning)—Catalog No. 800 describes this overthrow spreader stoker with continuous cleaning grates for boiler capacities of 5000 to 75,000 lb of steam per hr—efficient, flexible, dependable—burns all grades of bituminous and lignite coals and refuse fuels—smokeless operation.

499 PIPE FABRICATION

Dravo Corp., Machinery Div.—Bulletin 1704 illustrates a part of the firm's record of engineering construction of pipeline pumping and compressor stations for the transmission and storage of gas and petroleum products.

500 ELECTRONIC TEST EQUIPMENT

Panoramic Radio Products Inc.—A catalog digest contains condensed information on standard instruments for applications requiring high speed spectrum or waveform analysis. Included are sonic analyzers, sonic response indicator, signal alternator, triangular wave generator, ultrasonic analyzer, response indicator, sweep generator, spectrum analyzers, band-pass amplifier, oscilloscope cameras.

YOUR

New Catalogs GUIDE

501 TEMPERATURE, PRESSURE CONTROLS

Powers Regulator Co.—A 12-page booklet illustrates and describes nine basic types of temperature and pressure controls. Included are self-operating regulators, water mixing equipment, pneumatic control instruments, indicating and recording instruments and control valves.

502 SILICONE RUBBER COMPOUNDS

Acushnet Process Co.—Literature describes silicone rubber compounds and expanded services for the molding of precision parts now available from the company. Increased service temperatures to 500 F and for limited periods to 600 F are offered by five new compounds. Three compounds with low shrinkage characteristics in the 50 to 70 durometer range permit molding of parts and holding of close tolerance in existing tools.

503 BELT CONVEYORS

Transall, Inc.—Four-page brochure outlining the advantages of Transall prelubricated belt conveyor idlers. A check point list is included.

504 FLEXIBLE, SWIVEL, SWING, AND REVOLVING JOINTS

Barco Mfg. Co.—A group of catalogs cover joints for piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalies, and other fluids or gases. Complete range of sizes. Catalogs No. 215 "Flexible Ball Joints"; No. 265 "Rotary Swivel Joints"; No. 400 "Barco Swing Joints"; No. 310 "Revolving Joints" and No. 269 "High Pressure, Hydraulic Swivel Joints."

505 BELT FEEDER

Omega Machine Co. Div., B-I-F Industries, Inc.—Design features of Model 37-20 belt type gravimetric feeder are covered in Bulletin 35-N62. Unit is designed to feed more than 3000 lb per min.

506 AIR CONDITIONER

Westinghouse Electric Corp., Sturtevant Div.—Catalog 1635-B illustrates multi-zone units for central plant air-conditioning systems. They supply air mixtures, blended for simultaneous unequal heat load demands, in various zones requiring individual temperature and humidity control. Seven basic sizes, 4000 to 34,000 cfm, supplying individual zone requirements up to 16 zones in a single unit.

507 LOADING ASSEMBLIES

Jordan Industrial Sales Div. of OPW Corp.—A 24-page Catalog F-32R describes loading assemblies and accessory products. The catalog contains detailed product descriptions and photos, engineering information, dimensional drawings, installation layouts, and selection instructions.

508 PIPING SYSTEMS

Ric-Wil, Inc.—Revised product catalog covers construction features for prefabricated, insulated piping systems for steam, hot water, oil or refrigeration distribution lines. Types of systems covered include Hel-cor, Uniline, Type J, low temperature, and cast iron. Prefabricated accessories include expansion loops, elbows, gland seals, and tees.

509 MINIATURE COUPLINGS

Thomas Flexible Coupling Co.—Miniature couplings for use on servo-mechanisms, computers, missiles, and other devices requiring small-size components for power transmission, are described in Bulletin MC-100. The units are non-magnetic and light weight with low elastic yield under torque.

510 DRAFTING AID

Stanpat Co.—Circular available describing the firm's printed adhesive-backed acetate sheets for speeding of drafting. These sheets are attached to original drawings and save draftsmen from redrawing standard details and repetitive notes. Resulting prints are clear and sharp and save tremendous amount of time.

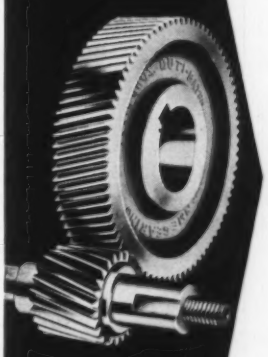
511 MAGNETIC DRIVES

Whitney Chain Co.—Eight-page technical bulletin illustrates and describes Tormag magnetic drives. The unit consists of two rotors, one of them magnetic, and is designed to protect all kinds of equipment from dangers of sudden, shock-loaded starts and stops.

PREMIUM GEARING at Production-Run Prices

Foote Bros. Offers Engineered Helical and Worm Gear Sets FROM STOCK

1638 Duti-Rated COMBINATIONS IN STOCK:



*Horsepower Ratings . . . . 1 to 200**
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Check with Foote Bros. *before* you finalize that design. The chances are you'll find exactly what you need among the 1638 *stock* combinations of Duti-Rated Helical Gears.

When you buy Duti-Rated Gearing, you'll get more than best for your money . . . you'll get the benefit of thousands of engineering and development hours . . . and the unquestioned advantages of precision tooling and manufacturing methods. You'll get performance proven in countless Foote Bros. Line-O-Power and special drives, and Foote Bros. —Louis Allis Gearmotors. This is high hardness, accurate, balanced design gearing that will give you more load capacity and wear life per dollar.

**Larger sizes made to order from standard tooling.*

Write for DUTI-RATED catalog: Engineering Manual DR No. 2.

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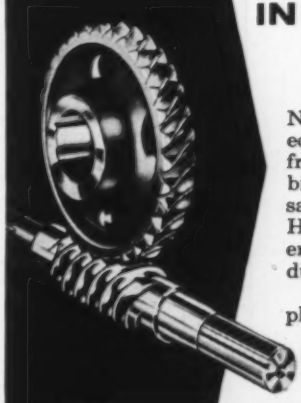

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Need worm gear and worm sets? There is economy and convenience in choosing them from the many Foote Bros. worm gear combinations available from stock. This is the same gearing used in famous Foote Bros. HYGRADE Enclosed Worm Gear Drives . . . engineered, premium quality gearing at production-run prices.

Engineering Manual SW No. 1 has complete details. Write for your copy.

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Let us help you select standard helical or worm gearing to meet your special requirements, or, let us design and build your complete unit. Place your gear problems in the hands of experienced power transmission and gear engineers. Your inquiry is invited, and there's no obligation.

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YOUR

New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

512 MINIATURE BALL BEARINGS

The Barden Corp.—Catalog Supplement MI gives dimensions, performance, and engineering data on precision ball bearings ⅛ in. OD and smaller. The bearings are used in instruments, aircraft accessories, computers and recorders, machine tool and textile spindles.

513 MAINTENANCE IDEAS

Kano Laboratories—An alphabetical list of ideas gathered from the correspondence of industrial customers deals with problems in lubrication, stuck together metal parts, difficult metal cleaning, and lubrication of air driven tools.

514 ROLL GRINDING MACHINES

Cincinnati Grinders Inc.—Illustrated catalog of 28 pages, describes the firm's line of these machines: 36, 44, 50, and 60 in. swing; between-center lengths from 10 to 24 ft in increments of two feet. Five pages of specifications and two pages of standard and extra cost equipment are included. Drawings give overall dimensions required for preliminary installation plans.

515 VARIABLE SPEED DRIVES

Stratos Div., Fairchild Engine & Airplane Corp.—Bulletin 200 describes the Specon variable speed drives and differential transmissions. Output speed ranges from 0–100 to 0–700 rpm. The units are designed with full torque at Zero speed to draw accuracies of .01 per cent. They are said to have shockless starts and to be fully reversible.

516 TEST BOILERS

Besler Corp.—A four-page folder covers features and advantages of high temperature, high pressure test boilers, designed to deliver steam up to 3000 psi and 1100 F. Units deliver steam within several minutes from cold start. One of the models handles loads from 500 to 15,000 lb-hr.

517 ELECTRONIC AIR CLEANING

Westinghouse Electric Corp., Sturtevant Div.—Supplement Catalog 1460 illustrates electronic air cleaning section with motorized washer and adhesive applicator. Capacities and dimensions are listed for 13 sizes for unitary installation or in-line assembly with air distributing units. It is designed specifically for application at normal cooling coil face velocities for central plant air conditioning, heating, and ventilating.

Your NEW CATALOGS Guide offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 517 items to make selections from. For convenience an index may be found on pages 157-159. Select desired catalogs by number, requests limited to 25 catalogs. Fill in coupon on page 158 and mail promptly. *(Must be mailed on or before date give on coupon.)*

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Manufacturers of mechanical packings, industrial and boiler gaskets, radio speaker gaskets, steel rule dies, flexible packing hooks.

"MONOBALL"®

Self-Aligning Bearings

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Dept. ME-58.

SOUTHWEST PRODUCTS CO.

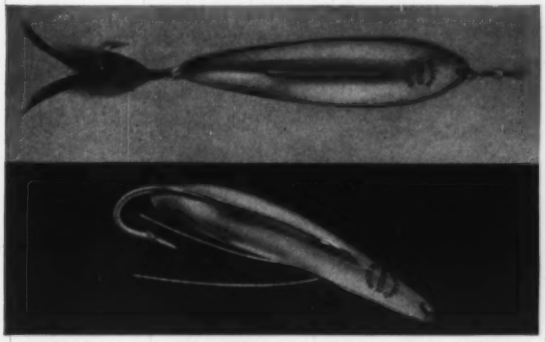
1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

NEW BRASS CUTS POLISHING COST

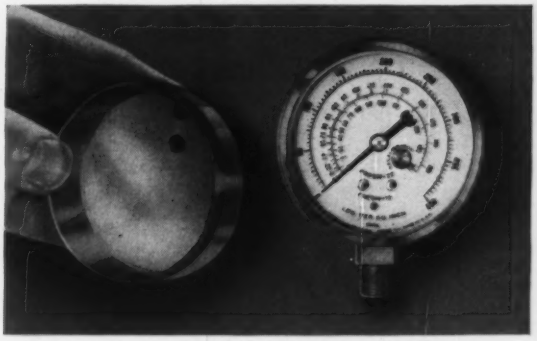
also gives you clean, easy drawing and forming, plus higher physical properties—Formbrite,® Superfine-Grain Drawing Brass by Anaconda

AIRGUIDE Instrument Co., Chicago, gets high luster finish on bezels for its famous weather instruments at 50% lower cost since it switched from ordinary drawing brass to Formbrite. Airguide does the presswork—says Formbrite "draws and forms excellently." Driscoll & Co. (above) polishes the bezels.

BAROMETER in Chippendale style, "Mayfair," is one of the broad line of brass-trimmed instruments made for home and marine use by Airguide.



FISHING LURES made by Williams Gold Refining Co., Inc.—"Wabler," top and "Weedler," below—are polished for plating by tumbling. Switching from ordinary yellow brass to Formbrite cut costs more than 40%.



MARSH Instrument Co., Skokie, Ill., dropped a finishing operation and gets a "mirror finish" with a light buff, by using Formbrite. Marsh reports that finishing cost was cut 40% and that forming is "excellent."

Wherever finishing is an important cost factor in formed or drawn products, Formbrite in sheet and strip is designed to save you money. In brass wire alloys for cold-heading and upsetting, it gives a stronger, springier, more abrasion-resistant product. For more detailed information, write for Publication B-39. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5843

FORMBRITE

SUPERFINE-GRAIN DRAWING BRASS

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ANACONDA®

Made by The American Brass Company

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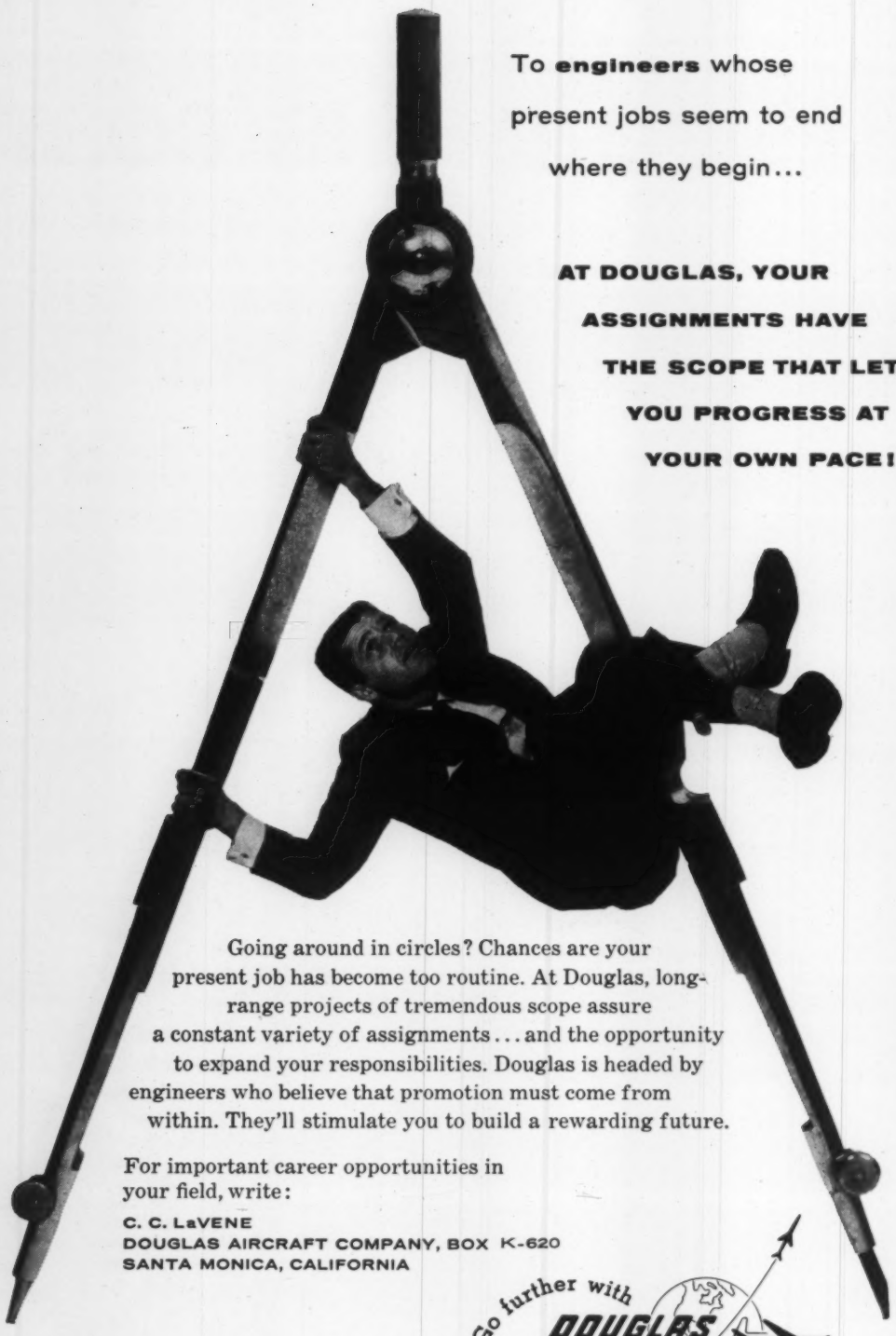
AT DOUGLAS, YOUR ASSIGNMENTS HAVE THE SCOPE THAT LETS YOU PROGRESS AT YOUR OWN PACE!



Going around in circles? Chances are your present job has become too routine. At Douglas, long-range projects of tremendous scope assure a constant variety of assignments... and the opportunity to expand your responsibilities. Douglas is headed by engineers who believe that promotion must come from within. They'll stimulate you to build a rewarding future.

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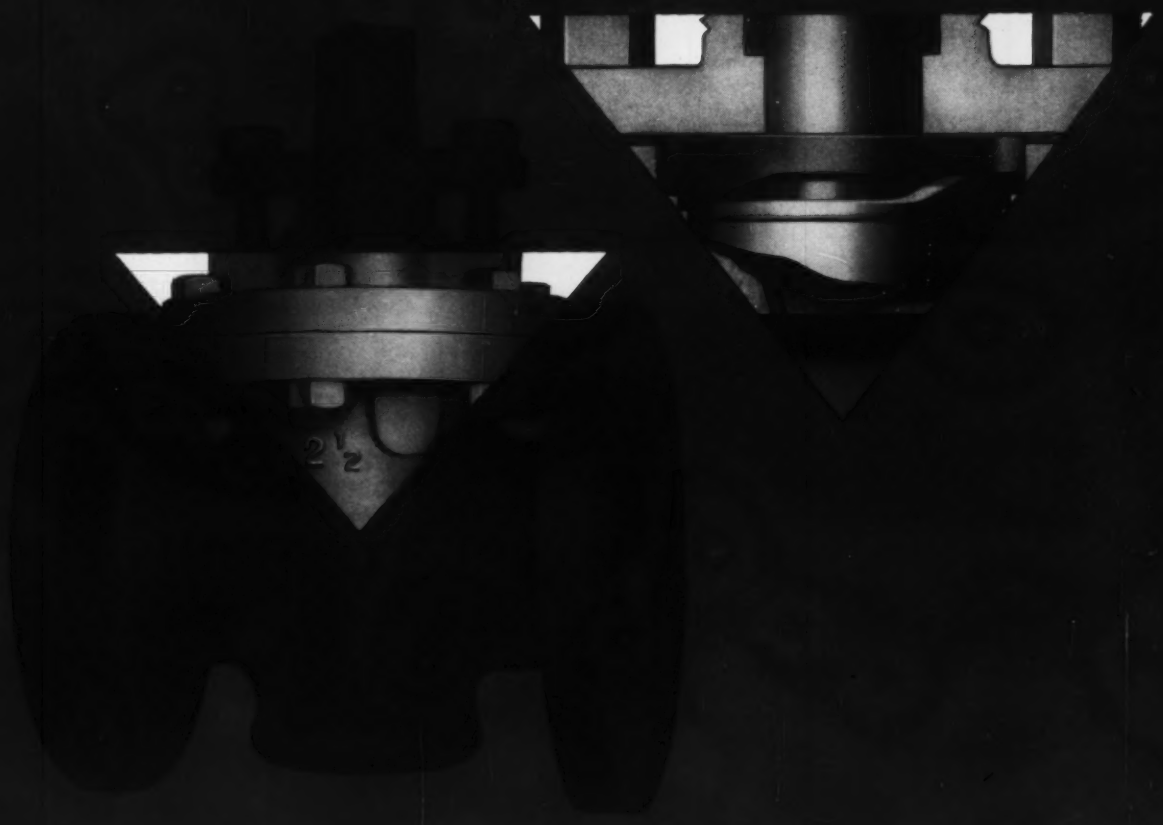
FIRST IN AVIATION

In the spots that count...Homestead Valves are

QUICK-ACTING



FASTER FLUID CONTROL is guaranteed by the quarter-turn action that fully opens or closes Homestead Cam-Seald Valves. A cam limits plug travel and automatically presses the matched seating surfaces of the plug and body together to form a leakproof, metal-to-metal seal. Additional design features such as the sealed bottom, seal between cap and body, the deep stuffing box, and the fact that fluid or grit cannot pass across the seating surface in the open or closed position, assure long, leak-free service. Write today for complete information—see how Homestead fills your needs.

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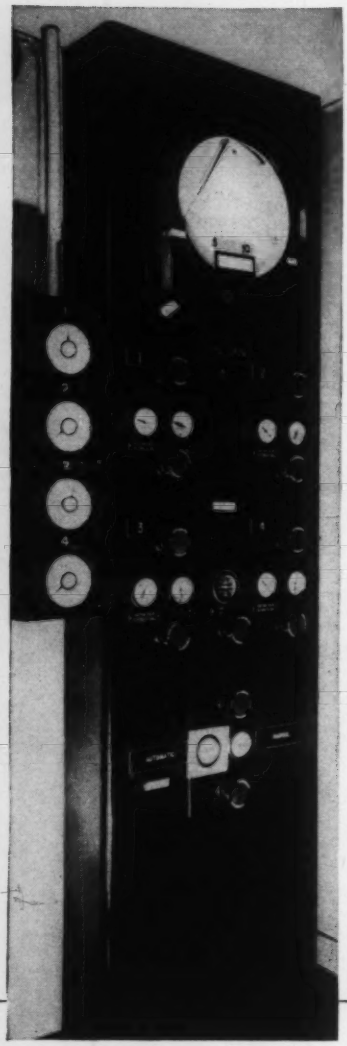


HAGAN CONTROL SPEEDS ANTIBIOTICS PRODUCTION—LOWERS COSTS

Precise compressor controls pay for themselves at Squibb plant

At the New Brunswick plant of E. R. Squibb and Sons, fermentation tanks containing the micro organisms which produce antibiotics depend on a constant supply of air. Any interruption increases the possibility of contamination, lowers production, and may involve complete loss of the batch.

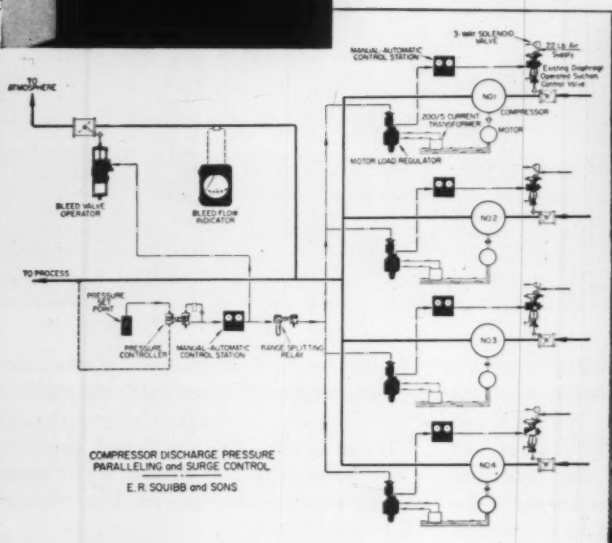
The manual controls on the four 12,000-cfm, 4-stage centrifugal compressors, used prior to the Hagan installation, made use of an elaborate alarm system and resulted in both overloading and surging of the compressors. At changeover, when a fermentation tank was added or removed from the line, excess air would be discharged into empty tanks to keep compressors from surging, and extra personnel were needed to handle valves and motor current controls.

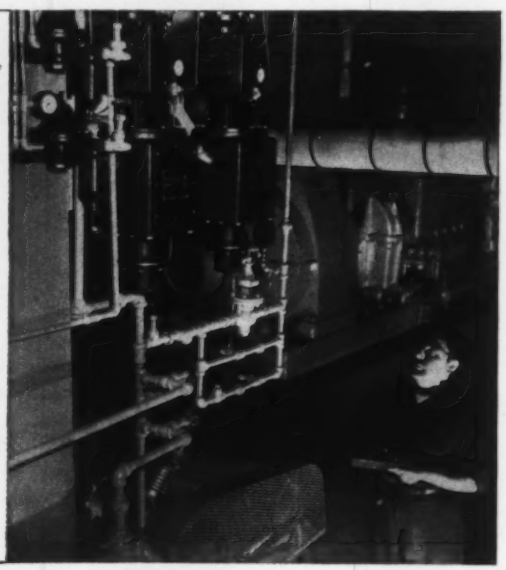
With the installation of the Hagan system, these problems disappeared. Both valves and motor current are now under automatic control, with the result that frequent starting and stopping of compressor motors has been curtailed, all tanks receive the proper air pressures, there is no need for extra operating personnel to handle changeover, and the compressor system as a whole is operating efficiently. The savings in personnel, in lower average power consumption and in higher production has more than paid for the system.

Hagan automatic controls for a great variety of processes are available as complete systems or as integrated components which may be linked together or made a part of existing controls. Hagan has pneumatic, hydraulic or electronic components which can be used in a variety of combinations. A Hagan engineer will be glad to work with you in solving your particular control problem. For more information, write or phone:

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO





The heart of the system is the pressure controller which maintains process air pressure by varying compressor motor load between allowable limits, and by controlling the bleed valve opening when compressor load has been reduced to minimum.

Two of the motor load regulators which receive a signal from the pressure controller. They prevent overloading or unloading (surging). Write for specification sheet GE500, which describes the Hagan Alternating Current Controller's unusual features.

THE CROSS COMPANY—Fraser, Michigan
This automation equipment producer's new plant has two 12-million btu C-E Hot Water Boilers.

CONVAIR-ASTRONAUTICS—San Diego, California
New Convair space-flight research center will have two 30-million btu C-E Hot Water Boilers.

RIVERVIEW COMMUNITY HIGH SCHOOL—Riverview, Mich.
Two 10-million btu C-E Hot Water Boilers heat Riverview's recently expanded high school.

U.S. AIR FORCE ACADEMY—Colorado Springs, Colorado
Choice of five C-E units here typifies widespread Air Force acceptance of high temperature hot water.

HIGH TEMPERATURE WATER

today's new idea in large space heating

In such diverse applications as industrials, large educational institutions, and military bases, high temperature water is finding rapidly increasing acceptance as an ideal means of heating large areas.

A big factor in bringing this trend about is The C-E La Mont Controlled Circulation Hot Water Boiler. Using the same principle as that applied by C-E in many of the country's largest utility boilers, this new boiler provides a degree of temperature control that makes it the most attractive method of heating in many cases. With a wide range of capacities—from 10 to 300 million Btu's—these boilers operate at water pressures up to 500 psi and temperatures to 470F, or higher. A C-E Hot Water Boiler can save from 10 to 20 per cent in maintenance and operating costs.

Combustion Hot Water Boilers in the smaller capacity range are completely assembled in the shop while the intermediate and large units are shipped in varying stages of assembly. This C-E practice greatly reduces erection costs.

So, if you are in the market for boilers, either for space heating or process requirements, it may prove greatly to your advantage to investigate the use of high temperature water as your heat source. Because individual needs vary, both steam and hot water have their place. Our engineers will be pleased to discuss either method with you or your consultants—impartially and with no obligation.

For further details on high temperature water boilers by C-E write for our catalog HCC-2.

COMBUSTION ENGINEERING

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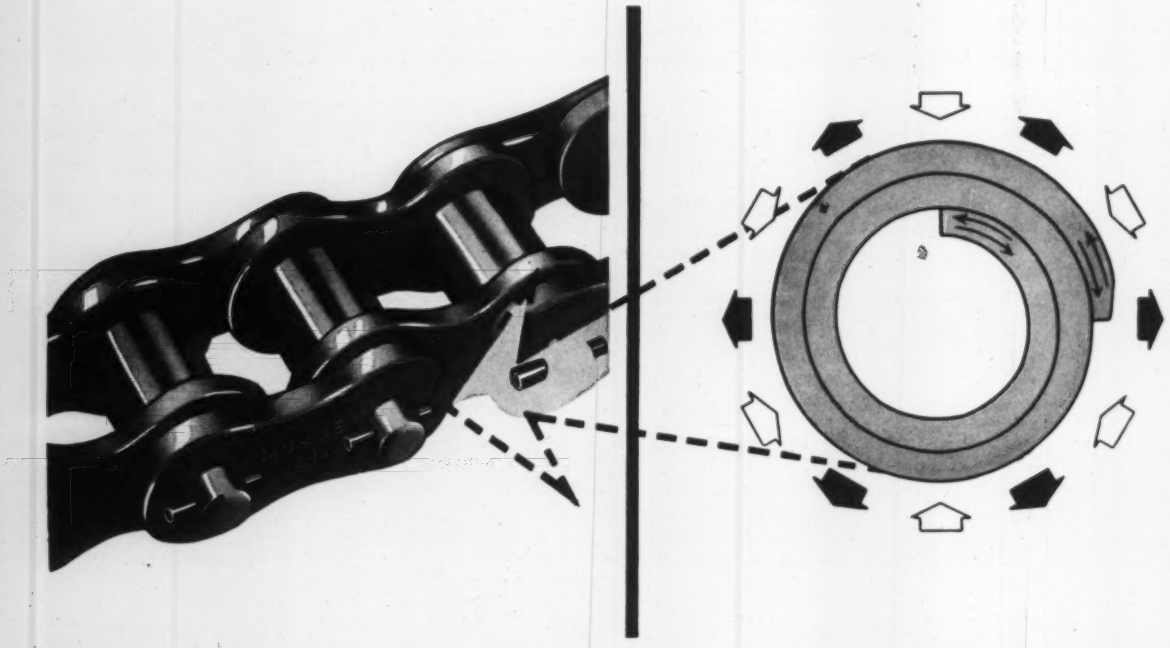
CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

C-120-A

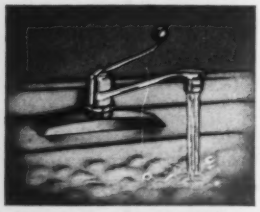
ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



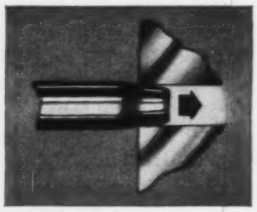
The true spring PIN has real spring *coils*

The spiral coils give SPIROL pins full spring action that is completely different from other flexible pins. Radial stress developed by compression is distributed *uniformly* throughout the spiral coils, — no critical cross-section. This characteristic enables SPIROL true spring pins to absorb high stress and shock, and withstand severe vibration. You gain the maximum benefits of cost reduction and design improvement only when you use a true spring pin with SPIROL's unique, coiled shape.

SPIROL coils offer these exclusive advantages

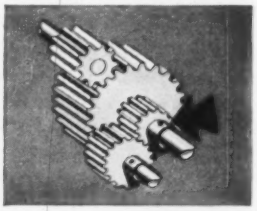


Non-heat-treated metals — such as low-cost brass, copper, nickel stainless steel — can be used in SPIROL true spring pins. Less resilient metals flex without failure, because there is no concentration of stress.



Wider hole tolerances eliminate reaming, reduce drilling rejects, cut production costs. Both plus *and* minus tolerances are allowed because of SPIROL spring pin's greater flexibility in expansion and compression.

Miniature sizes retain flexibility and strength of the spiral cross-section. SPIROL is the only spring-type pin made in miniature diameters: 1/32" — .039" — 3/64" — .052". Standard diameters up to 1/2" in stock.



Shock resistance — extremely high resistance to shock, shear, and vibration permits use of "medium duty" SPIROL pins in the majority of applications. Heavy and light duty SPIROL pins are also available in stock.

FREE! *Write for complete literature on* SPIROL *spring pins, including price list.*

® **SPIROL** *the true spring* **PIN**

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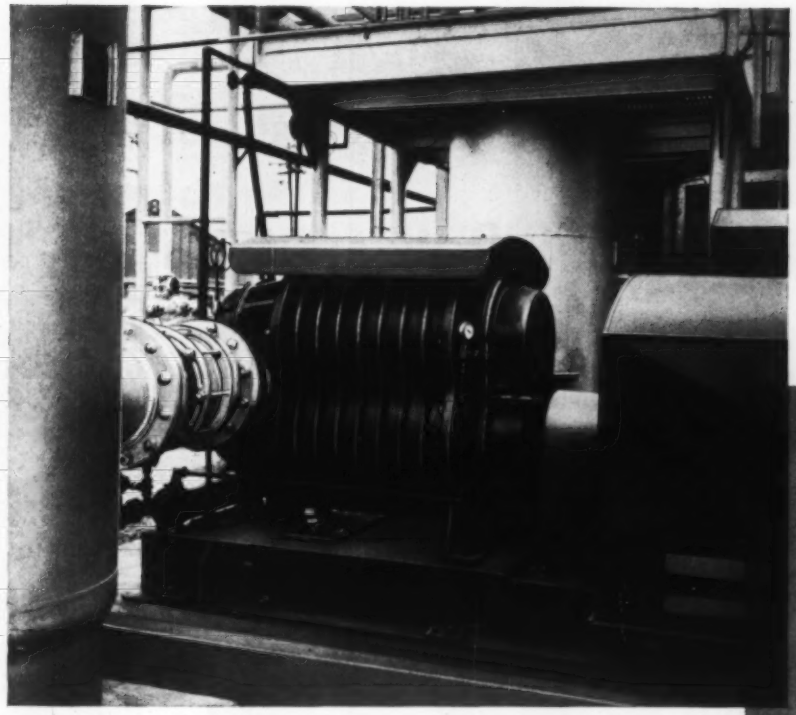
AT KERR-McGEE OIL INDUSTRIES REFINERY

KERR-McGEE



14 x 27 Spiraxial Compressor
delivers 3456 cfm at
28 psi discharge operating
at 1800 RPM requiring 450 HP.

- Sized for direct-connected drives with motors, engines or turbines, at speeds from 1,750 to 3,550 RPM.
- Peak efficiencies at required discharge pressures.
- Uncooled — requires no water jacketing.
- No internal lubrication — delivers oil-free air.
- Small space — low noise level.
- Capacity ratings range from 700 cfm to 5,000 cfm, with pressures from 8 psi to 30 psi.

Rugged round-the-clock service without shutdown... thanks to R-C SPIRAXIAL® COMPRESSOR

The Cushing, Okla. Refinery of Kerr-McGee Oil Industries recently installed this 14 by 27 R-C Spiraxial Compressor and ran it for six months on a rugged 24 hour a day schedule—*without shut down or difficulties of any kind!*

The unit supplements the air supply to the regenerator and has helped increase throughput by 550 bbls. per day. Thus only a 1-year's run will pay for the installation!

Such sturdy, dollar-wise performance is typical of R-C Spiraxial units for refinery and many other types of service. Engineered with R-C patented Rotor Design, they insure greater efficiency, dependability and economy . . . require no water jacketing . . . reduce substantially both first cost *and* maintenance. Variable compression ratios widen the range of uses. Absence of internal lubrication assures oil-free air.

A product of progressive engineering, R-C Spiraxial Compressors are built to the same high standards of manufacture that have made Roots-Connersville the symbol of compressor dependability throughout the world.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

458 Michigan Avenue, Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto, Ont.

For additional data,
please refer to our section
in **Chemical Engineering Catalog**
or **Mechanical Catalog**
or write for Bulletin LAL-458.

ABOUT MEN AND WEAPONS

For centuries men have tried to develop new and more powerful weapons to achieve victory in war.

Lately these have been weapons of unprecedented power.

Now war can become race suicide, and victory thus gained is a delusion.

Yet we keep on trying to develop new and more powerful weapons, because we must.

Not because we seek victory through a nuclear war, but because through strength we may prevent one.

For as long as there are powerful forces with a record of cynical duplicity and oppression, the free world must have weapons capable of neutralizing them.

At least until men learn that the only alternate to peace is oblivion.

At Sandia, we play an important part in providing this protective strength. Our scientists and engineers are responsible for research, design, and development of nuclear weapons for the Atomic Energy Commission. This makes these men exceptionally valuable assets in our nation's efforts to secure the future.

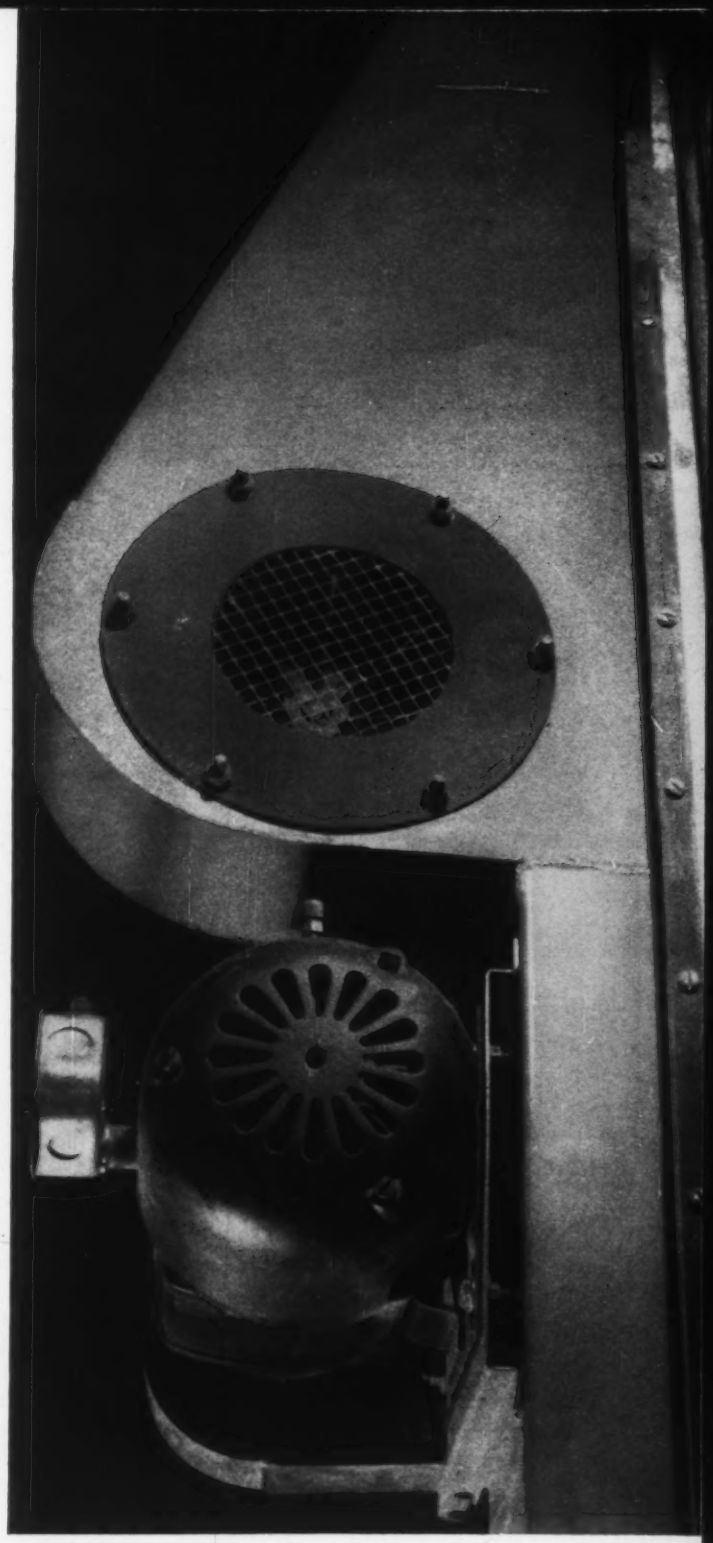
We need more such men — outstanding engineers and scientists in many fields, especially at the highest academic and experience levels. At Sandia in Albuquerque and at our branch laboratory in Livermore, California, we need their knowledge, skill, and perseverance.

If you can help us meet this need, or if you know anyone who can, write Staff Employment Section 553.

SANDIA CORPORATION

ALBUQUERQUE. NEW MEXICO

You're looking at the exclusive key to continuous dust collecting!



You are inside a Pangborn Dust Collector. And this is Pangborn's traveling manifold . . . the exclusive self-cleaning development that permits continuous suction at highest efficiency. The result is the incomparable performance of cloth type collectors with minimum resistance to air flow and with no shutdown required.

Typical Pangborn engineering . . .

This advance is particularly important in collecting finely-divided dry dusts. But the Pangborn engineering it typifies is important to *any* dust-producing plant. It is not enough to place a dust collector within a plant. An efficient dust collecting system must be *scientifically* planned, designed and constructed to handle effectively a specific dust problem. This *thinking* is incorporated into every Pangborn proposal.

. . . that can help you

One of Pangborn's comprehensive line of dry and wet dust collectors can be utilized in a Pangborn-engineered dust system to solve *your* dust problem . . . whether it involves any kind of fine, coarse, dry, moist, corrosive, hot or obnoxious dusts.

The Pangborn engineer in your area will be glad to take off his jacket and go to work for you. He is a dust *expert* and will discuss your individual problem at no obligation. And, for more information, write for "Out of the Realm of Dust" to: PANGBORN CORP., 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment.*

Pangborn CONTROLS DUST

NOTABLE ACHIEVEMENTS AT JPL...

THE FIRST AMERICAN SATELLITE

With the launching of the ' Explorer," in joint co-operation with the Army Ballistic Missile Agency, the Caltech Jet Propulsion Laboratory fulfills one of its prime functions as a pioneer of the future.

The Army's request for JPL to join in the effort to put an American satellite in orbit was the type of appeal most likely to arouse the enthusiasm of the Laboratory personnel — nearly 2,000 of them.

Challenged by this exceptional opportunity, JPL personnel designed and fabricated the final three stages of the Jupiter "C" missile and, in addition, designed and developed the satellite itself in 80 days.

The close co-operation and co-ordination of effort with the ABMA and the U. S. National Committee for the IGY, make JPL proud to have been a close partner with the U.S. Army in developing and launching the first American satellite.

Now, JPL, maintaining its established policy of scientific research, continues to assist in tracking, receiving, correlating and evaluating data from the "Explorer" as one of its many contributions toward solving the problems of the future.

CAREER OPPORTUNITIES NOW OPEN IN THESE FIELDS

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JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA • CALIFORNIA

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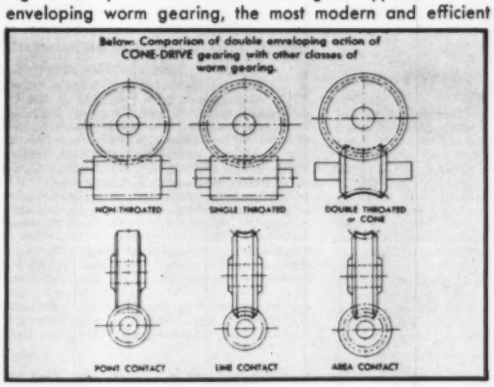
How to get the most out of Worm Gearing

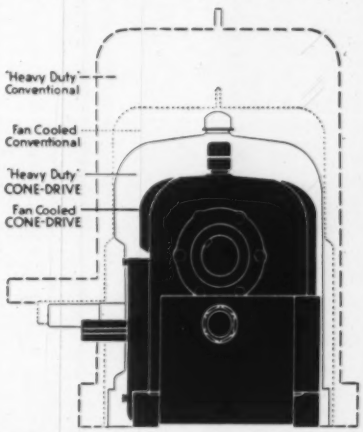
If a right-angle drive is needed in your product and you require maximum capacity for your dollar, then the Cone-Drive double-enveloping type will give it to you. The sketch below shows the apparent advantages of Cone-Drive gearing as compared to other worm gear types. Double-enveloping worm gearing, the most modern and efficient


Below: Comparison of double enveloping action of CONE-DRIVE gearing with other classes of worm gearing.
NON THROATED
SINGLE THROATED
DOUBLE THROATED or CONE
POINT CONTACT
LINE CONTACT
AREA CONTACT

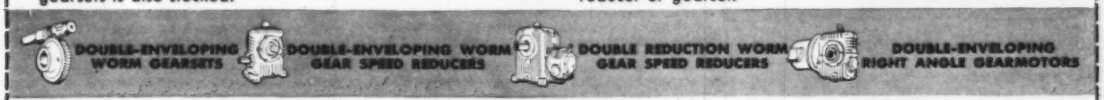
form, has straight-sided teeth in both worm and gear. Both elements of Cone-Drive are throated and envelop each other, providing a multiple tooth area contact. This means greater load-carrying capacity than is possible with any other type of worm gearing.

Double-enveloping worm gearing is available from Cone-Drive Gears in complete lines of gearsets, speed reducers and gearmotors. Gearsets are stocked in center distances from 2" thru 24", capable of handling loads from fractional to over 1600 horsepower. A complete line of mountings for gearsets is also stocked.

Speed reducers and gearmotors with Cone-Drive double-enveloping worm gearing are unusually compact and powerful drives that handle shock loads with ease. Yet, they provide power transmission smoother than that of hydraulic systems. Another advantage, unique to double-enveloping worm gearing, is their ability to regenerate themselves when wear occurs. Both worm and gear tend to reproduce the correct form in the other when wear occurs.



Double-enveloping worm gearing with its "wrap-around design" requires shorter center distances than cylindrical worm gearing to handle the same loads. As a result, Cone-Drive speed reducers have smaller housings with corresponding savings in weight and space. Bulky gear trains can often be replaced with a single Cone-Drive speed reducer or gearset.


DOUBLE-ENVELOPING WORM GEARSETS
DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS
DOUBLE REDUCTION WORM GEAR SPEED REDUCERS
DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

CONE-DRIVE GEARS
DIVISION MICHIGAN TOOL COMPANY
7171 E. McNichols Road • Detroit 12, Michigan
Telephone: TWinbrook 1-3111

Please send me information on following:

☐ Gearsets ☐ Gearmotors ☐ Speed Reducers

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Engineers' Reference Books

Published by
The American Society of Mechanical Engineers

77-YEAR INDEX TO ASME TECHNICAL PAPERS

Published 1957. $20.00—This is an index to the technical papers published in the ASME Transactions, the Journal of Applied Mechanics, and Mechanical Engineering for the past seventy-seven years. It is divided into two parts with the first covering the papers published between 1880 and 1939, and the second, indexing those published from 1940–1956. Each part has a subject and an author index. The former lists the titles of the papers chronologically under as many headings as are necessary and includes numerous cross-references to direct attention to related material. The alphabetically arranged authors' index gives the headings and the year under which each paper is listed in the subject index.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON FATIGUE OF METALS

Published 1957. $13.00.—Included are the eighty-one papers given at the 1956 International Conferences held in London and New York, the discussions submitted at both Conferences, the reports of the opening and closing sessions, and the reporters' introductory remarks. All in all an invaluable collection of information with coverage ranging from the basic aspects of fatigue to stress distribution, temperature frequency and environment, metallurgical aspects, and engineering and industrial significance of fatigue. CONTENTS: Basic Studies. Stress Concentration, Combined Stress Tests, Effect of Mean Stress. Cumulative Damage, Statistical Aspect, Repeated Strain Cycling, Effect of Frequency. Effects of Temperature, Metallurgical Aspects, Light Alloys, Corrosion. Engineering and Industrial Significance of Fatigue. Automobiles, Aircraft Engines, Marine Machinery, Railroad Equipment, Welded Construction, and Aircraft Structures.

ELEVATED TEMPERATURE PROPERTIES OF:

Each of the following reports is a graphical summary of the elevated-temperature strength data collected. Each includes summary curves of tensile and yield strength, elongation and reduction of area, rupture, and creep rates; also data sheets giving the chemical composition, processing data, heat treatment, and other pertinent information about the steels included in the respective surveys.

1	Copper and Copper Alloys	1956	$5.50	$4.25*
2	Carbon Steels	1955	3.75	2.80*
3	Selected Super-Strength Alloys	1954	4.75	3.50*
4	Chromium Molybdenum Steels	1953	4.75	3.50*

*Prices to ASME members

METALS ENGINEERING-DESIGN

Published 1953. $10.00—This book discusses the essential properties which need to be evaluated by the design engineer in his selection of one material over another. Comprising 48 sections and written by 43 well-known authorities, it deals with the over-all problem of selection of material and takes up such specific items as high temperature considerations, plasticity, residual stresses, vibration, fatigue, shot peening, cold working, nitriding, flame strengthening, impact, corrosion, non-destructive testing, surface finish and mass production, and design theory and practice.

METALS PROPERTIES

Published 1954. $11.00—Provides, in convenient charts and tables, data on a broad range of metals in common industrial use —AISI steels, ASTM steels, cast copper alloys, aluminum alloys, tin, magnesium, etc. Tabulated under each of the more than 500 metals listed is such information as the chemical composition of the metal; its brittleness, heat treatment and other characteristics; its industrial uses; treatment temperatures for forging, annealing, quenching, etc.; such technological properties as recrystallization temperature and hot working temperature, and a great deal of other pertinent information to help the designer choose the proper metal for each part or product.

ENGINEERING TABLES

Published 1956. $12.00—A collection of tables often wanted by engineers but not commonly found in handbooks covering: Bar Stock and Shafting. Conversion Factors. Formulas for Stress and Strain. Properties of Sections and Cylinders. Bearings. Bearing Load Analysis. Spur Gears. Helical and Herringbone Gears. Bevel Gears. Worm Gears. Cylindrical Fits. Standard Tapers. Keys and Keyseating. Bolts. Counterbores. Screw Threads. Slots. Serrations and Splines. Nuts. Pins. Snaprings. Washers. Wrench Openings. Springs. Aircraft and Mechanical Tubing. Pressure Tubes. Pipe. Pipe Threads and Fittings. Electric Motors. Graphical Symbols. Welding. Gaskets. Hydraulic Standards and Symbols. O-Rings. Packings. Seals. Bibliography.

ADVANCES IN NUCLEAR ENGINEERING (2 VOLUMES)

Published 1957. $35.00—Volume I contains the sixty-two contributions concerned with the manufacture, production, recovery, and economics of nuclear fuels; spent fuel processing; plant containment concepts and design; plant components; waste disposal; protection and safety measures; and radiation processing. It also includes a resumé of the international outlook for atomic power. Volume II includes the seventy-three articles dealing with reactor design; reactor core design; operation and maintenance of reactors; metallurgy; heat transfer and heat evolution; educational uses of reactors; and standardization planning in the nuclear field. Each volume has a subject and authors' indexes. The 130-odd paper in these volumes were presented at the 2nd Nuclear Engineering and Science Conference, sponsored by the 1957 Nuclear Congress.

HOT LABORATORY OPERATION AND EQUIPMENT

Published 1957. $17.50—Here is the rich fund of information on the design and construction of hot laboratory facilities; the equipment for hot chemical, physical, mechanical, and metallurgical operations; operation and administration of hot laboratories, hot cell installations; and specialized hot operations. Author and subject index included. These contributions were given at the 5th Hot Laboratories and Equipment Conference, also sponsored by the 1957 Nuclear Congress.

Combination price of "G" and "H": $45.00

GLOSSARY OF TERMS IN NUCLEAR SCIENCE AND TECHNOLOGY

Published 1957. (ASA No. N1.1.) $5.00 This 188-page American Standard contains the precise definitions of 1500 technical terms used in the nuclear field, as well as tables, charts and formulae considered useful. The terms included are those coined expressly for the nuclear energy field, those borrowed from other fields and employed here with a different meaning, and those used elsewhere, but which may be unfamiliar to nuclear engineers. In short, this first standard dictionary of the nuclear energy field provides a common language among engineers, physicists, chemists, biologists, medical men, and others working with the atom.

POWER REACTORS

Published 1958. $3.00—Presents information about types of power reactor plants and their experimental prototypes that are designed to produce electric power. For each plant a data sheet is provided, giving as much of the following information as was supplied up to the time of printing: Plant Location. Reactor Type. Nominal Megawatt Rating of Reactor. Net Electrical Plant Output. Sponsor. Operator. Designer. Constructor. Present Status. Start of Construction. Reactor Critical Date. Full Power Operation Date. Plant Cost. Power Data. Nuclear Data. Fuel Element and Blanket Description. Reactor. Reactor Control. Primary Coolant System. Secondary Coolant System. Steam System.

PROCEEDINGS OF THE 1957 DESIGN ENGINEERING CONFERENCE

Published 1957. $4.00—There is a wealth of information in this book for those responsible for the creation of new products, and the redesign of existing ones. Here will be found a discussion by top authorities of recent advances in the field of general design; new developments in design of gearing, cams, machine tools, and for easier machining; new materials and their uses; and procedures for developing new designs. CONTENTS: Procedures in Developing New Designs. New Developments in Design and Application of Gearing. New Developments in Design and Application of Cams. Metallic Materials. Ceramics and Refractory Materials. Selecting Motors with New Nema Frame Sizes. Static Switching Devices. Designing for Easier Machining, Handling and Assembly. Hopper Feeding. Plastics and Rubbers. Coatings and Finishes. Numerical Control for Machinery. Designing Machine Tools for Automatic Controls.

SHOCK AND VIBRATION INSTRUMENTATION

Published 1956. $5.00—This book provides a fund of useful information on recent advances and new concepts in the technology of shock and vibration. Among the subjects discussed are random vibration, effect of non-rigid structures on vibration isolation, hysteresis and slip damping, vibration and shock testing, design approaches and analog methods. CONTENTS: Evaluation of Mounts Isolating Nonrigid Machines from Nonrigid Foundations. Experimental Study of the Effects of Foundation Resilience on Vibration Isolating. Effect of Material and Slip Damping on Resonance Behavior. Shock and Vibration Environments. Mechanical Design for Random Vibration and Shock. Influence of Electrical and Motional Impedance on the Control and Performance of Some Vibration Machines. Shock Testing Machines and Procedures. Damaging Potential of Shock and Vibration. High Speed Computing Methods for Shock and Vibration Problems.

PROCEEDINGS, 1957 OIL AND GAS POWER DIVISION CONFERENCE

Published 1957. $3.00 — CONTENTS: Variations in Marine Engine Performance With Departures From Design. Chromium Plating Development at U. S. Naval Engineering Experiment Station. Sizing of Centrifugal Separators for Residual Fuels. Use of Heavy Fuels on River Towboats With High Speed Diesel Engines. A Practical Enginescope for Field Maintenance. A Study of Industrial Engine Operation. Effect of Intake Combustion Air Conditioning on Performance of Spark Ignition Gas Engines. Turbocharger Development for Loop-Scavenged Two-Cycle Gas Engines. Gas Pulsations—The Problem, Approach, and Results. An Appraisal of Compressor-Cylinder Cooling Requirements. Piston Rings for Oil and Gas Engines. Engine Intake Air Conditioning.

1956 REPORT ON OIL AND GAS ENGINE POWER COSTS

Published 1957. $3.00—Contains statistics for 1955 and previous years. Data for 1955 come from 94 plants. Given for each plant, are the costs of fuels and lubrication; attendance and superintendence, maintenance and repair and information on type of engine, kind of fuel, installed capacity, type of load, major repairs, number and duration of enforced shutdowns. Comparative costs figures for past years are also presented.

RESISTANCE OF VARIOUS MATERIALS TO CAVITATION DAMAGE

Published 1957. $3.00—This report contains information regarding the relative resistance of various materials to cavitation damage and is based on years of field experience under operating conditions and laboratory tests with accelerated cavitation machines. It also shows the correlation between these tests and experience and discusses the merits of several new materials and new methods which have been developed to give better cavitation resistance. Tables, photographs and charts supplement the text.

DYNAMICS OF AUTOMATIC CONTROLS

Published 1948. $6.00—A book for both the practical and theoretical worker, it discusses the dynamic properties which all controllers possess in common, provides information on the functional elements of a control and the mathematical methods for handling control problems. It considers the important components of the control loop and special control problems. The causes of nonlinearities in the control loop, and the on-off regulator and its field of application are studied, also the theory of the excursion-dependent periodic controller. Appendixes list formulas for the Laplace transformation, for difference equations, and for typical elements and combinations of the dynamical circuit.

FREQUENCY RESPONSE

Published 1956. $7.50—Design technique based on frequency response is now a prime analytical tool in numerous branches of modern techniques. Frequency Response offers an unparalleled amount of information on this tool. Covering the entire field from basic theory to experimental techniques, this book orients the reader in regard to historical developments, fundamental theory, and significant advances; describes frequency response aids such as types of sine wave generators for obtaining data, slide rules and nomographs for facilitating computation; discusses and illustrates the application of experimental methods of frequency response to process controls, servomechanism design and power systems; covers process control behavior, transient response, optimum control, nonlinear techniques, sampling controls and statistical approach to servomechanisms and regulators.

DESIGN DATA AND METHODS

Published 1953. $4.00—This 200-page compilation includes formulas and methods of calculating stresses in beams, bars, columns, plates, shafts, and crane hooks; stress component formulas; procedures for computing stresses and deformation in pressure vessels; design data on press- and shrink-filled assemblies and also for piping; factors of working stresses; numerical values of tangential stress in thick-walled cylinders; numerical solution of problems of gas flow when properties change continuously; method of characteristics for two dimensional supersonic flow; chart for oblique shock waves under water; accurate bearing calculations; and methods of treating and solving problems of vibration and balancing of rotating apparatus.

PROBLEMS AND CONTROL OF AIR-POLLUTION

Published 1955. $7.50—Includes authoritative material on the treatment and recovery of sulphur dioxide, many helpful ideas on new developments and control, reports of experiences in air-pollution abroad, suggestions for avoiding pitfalls in community relations with air-pollution problems, and much other information useful to those concerned with the medical, biological, and meteorological aspects of air-pollution. CONTENTS: The Growth of Public Opinion. Management and Biological Aspects of Air-Pollution. Administrative Needs and Patterns of and Engineering Research and Development in Air-Pollution Control. Meteorological Problems. Biological Systems for the Identification and Distribution of Air-Pollution. Associated Health Implications in Air-Pollution Control. Exhaust Gases from Diesel Engines. Research Findings in Standards of Incinerator Design. Measurement of Average Particle Size in Aerosols by Light Scattering. The Sarnia Survey: The World Supply of Sulfur. Removal of Sulfur Dioxide from Power-Plant Stack Gases. Recovery of Sulfur Dioxide from Coal Combustion Stack Gases. Ammonia Process for Removal of Sulfur Dioxide from the Flue Gas. Recovery of Refinery Sulfur in Air-Pollution Control. Sulfur in Iron and Steelmaking. Recovery and Utilization of Sulfur from Coke Oven Gas. Use of a Sulfur Dioxide Scrubbing System in Air-Pollution Control. Influence of the Size of the Dust Outlet on the Efficiency of Cyclones. Air-Pollution in Holland. Abiotic Disease in Forest Species. Industrial Atmospheric Pollution in Italy. Air-Pollution by Dust, Fume and Smoke.

VISCOSITY OF LUBRICANTS UNDER PRESSURE

Published 1954. $5.00—This publication reviews and coordinates twelve experimental investigations, made over a period of thirty-five years, on 148 lubricants comprising of 25 fatty oils, 94 petroleum oils, 17 compounded oils and 12 other lubricants. Data are coordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Computation of the temperature coefficients of viscosity and the method of computing pressure coefficients are also given.

MATERIALS HANDLING HANDBOOK

Published 1958. $20.00—With this new Handbook you have the means for analyzing your own materials handling operations, planning for greater efficiency, installing and operating important systems, and measuring results. Illustrations, tables, cost, and work flow forms put best current practice at your finger tips. CONTENTS: Definition and Scope of Materials Handling • Analyzing Materials Handling Problems • Materials Handling Factors • Factory Planning • Materials Positioning in Production • Materials Handling Research • Materials Handling and Production Control • Communication Systems • Training Personnel • Handling Bulk Materials • In-Process Handling of Bulk Materials • Unit Handling for Various Shapes • Unit Handling in Manufacturing • Scrap Classification and Handling • Uses of Containers in Industry • Industrial Packaging • Palletization • Warehousing and Yard Handling • Truck Terminal Handling • Railroad Terminal Handling • Marine Terminal Handling • Air Terminal Handling • Belt Conveyors • Elevating Conveyors • Chain Conveyors • Trolley Conveyors • Cable Conveyors • Haulage Conveyors • Vibrating and Oscillating Conveyors • Pneumatic Conveyors • Package Conveyors • Fixed Cranes, Derricks, and Cableways • Traveling Cranes and Towers • Portable Cranes • Elevators • Winches • Auxiliary Crane Equipment • Positioning Equipment • Powered Industrial Trucks • Industrial Hand Trucks • Industrial Tractors • Highway Trucks and Truck-Trailers • Railroad Freight Cars • Marine Carriers • Air Carriers • Containers.

MANUAL ON CUTTING OF METALS WITH SINGLE POINT TOOLS

Published 1953. $10.00—This book contains shop-tested data on the machining of high nickel alloys, stainless steels, copper and brass alloys, magnesium, cast irons and plastics. It offers valuable information on the structure of the metals to be machined, the correct tool material, size and shape of cut, and the proper cutting fluid. It shows how to predetermine the power requirements and best operating speed for all jobs. It helps time study men to set standards of practice and cost of production, and it provides 322 tables of cutting speeds and horsepower for various feeds and depths of cut when turning commonly used steels and cast iron.

THERMODYNAMIC PROPERTIES OF COMPRESSED WATER

Published 1957. $2.50—Here is a chart that fills the need for an accurate and convenient presentation of the thermodynamic properties of compressed water. These properties which include temperature, pressure, specific volume, enthalpy and entropy, are presented graphically in a large scale chart broken up into fifteen plates. The temperature range covered is from 32 to 705.4°F and the pressure range, from 0.08854 to 6000 PSIA.

STRUCTURES FOR THERMAL FLIGHT

Published 1956. $3.00—The problem areas herein covered are materials at elevated temperatures, optimum airframe structures, factor of safety concepts, and elevated temperature testing techniques. CONTENTS: Challenge of Progress. High Speeds Problems of Large Airplanes. Aluminum Alloys for Elevated Temperature Service. Application of a New Structural Index to Compare Titanium Alloys with Other Materials in Airframe Structures. Optimum Stresses of Structural Elements at Elevated Temperatures. Thermostructural Efficiencies of Compression Elements, and Materials. Weight Efficiency Analysis of Thin Wing Construction. Design Criteria for Heated Aircraft Structures. Some Structural Penalties Associated with Thermal Flight. Aircraft Structural Testing Techniques at Elevated Temperatures. Some NACA Research on the Effect of Transcient Heating on Aircraft Structures. Utilization of Solar Furnaces in High Temperature Research.

DIRECTORY OF CONSULTING ENGINEERS

Published 1957. $2.50—This Directory lists the names and addresses of ASME members who are consulting engineers and of engineering organizations with which they are associated—approximately 1200. The listing is both alphabetical and geographical, with the latter including a brief statement of the specialty of each entry.

MANUAL OF CONSULTING PRACTICE FOR MECHANICAL ENGINEERS

Published 1956. $1.50—This guide for consulting engineers and their clients sets forth the proper approach in obtaining professional engineering services, in establishing the fundamental structure in engineering agreements, and of engineering services under the various types of agreements.

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Published 1957 $12.50

CONTENTS: General: Chemistry and Physics of Combustion. Scientific Principles of Combustion and Their Application. Appraisal of Combustion Research. Boilers: Instruments as Applied to Detection of Flame Failure. Methods of Disposal and Elimination of Petroleum Refinery Waste Gases. Furnaces for Low-quality Solid Fuels. Effect of Fuel Properties on Firing Methods. Boiler Availability. Liquid-fuel Firing. Combustion of Pulverized Fuel for Steam Generation. Development and Practice of Cyclone Firing in Germany. Spreader Stokers and Combustion. Industrial Furnaces: Gas as a Source of Protective Atmosphere in Industrial Furnaces. Status of Combustion in Industrial Furnaces. Instruments as Applied to Product Improvement in Steel Furnaces. Instrumentation of Process Tubular Heater H. T. Gaseous Jets as Applied to Some Manufacturing Processes. Combustion and Heater Transfer in Open-hearth Furnace. Oil Burners for Open-hearth Furnaces. Advances in Cupola Combustion. Combustion and Heat Transfer in Glass Tanks. Combustion and Thermal Transfer in Continuous Reheating Furnaces. Internal-Combustion Engines: High-compression Turbocharged Spark-ignition Gas Engines. Heat Release Rates in Hydrocarbon Combustion. Surface Ignition in a Motored Engine. Compression Products and Wear in High-Speed Compression-ignition Engines. Combustion in Large Diesel Engines, in Diesel Engines with Divided Combustion Chambers, in Petrol Engines, and in Dual-fuel Engines. Gas Turbines: Application of Electronic Probes to Measurements in Turbulent Flames. Iridium versus Iridium-Rhodium Thermocouples for Gas-temperature Measurements up to 3,500 F. Coal Firing for the Open-cycle Gas Turbine. Combustion of Blast-furnace Gas in Gas Turbines. Relation of Specific Heat Release to Pressure Drop in Aero-gas-turbine Combustion Chambers. Combustion Chambers and Control of Temperature at Which They Operate. Use of Solid Fuel in the Gas Turbine. Operating Experience with Combustion Equipment in Industrial Gas Turbines. Combustion of Residual Fuel in Gas Turbines. Application of Research to Gas-turbine Combustion Problems.

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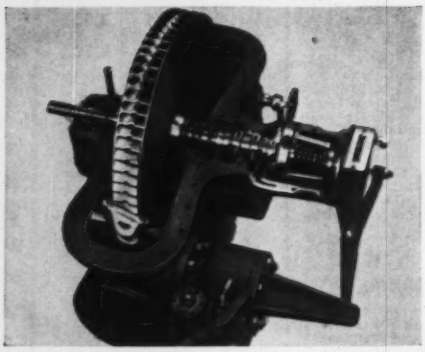
TURBINE BLADES CAN'T FOUL!

The Terry solid-wheel turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.



Terry solid-wheel design permits large clearances

In the Terry solid-wheel turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.

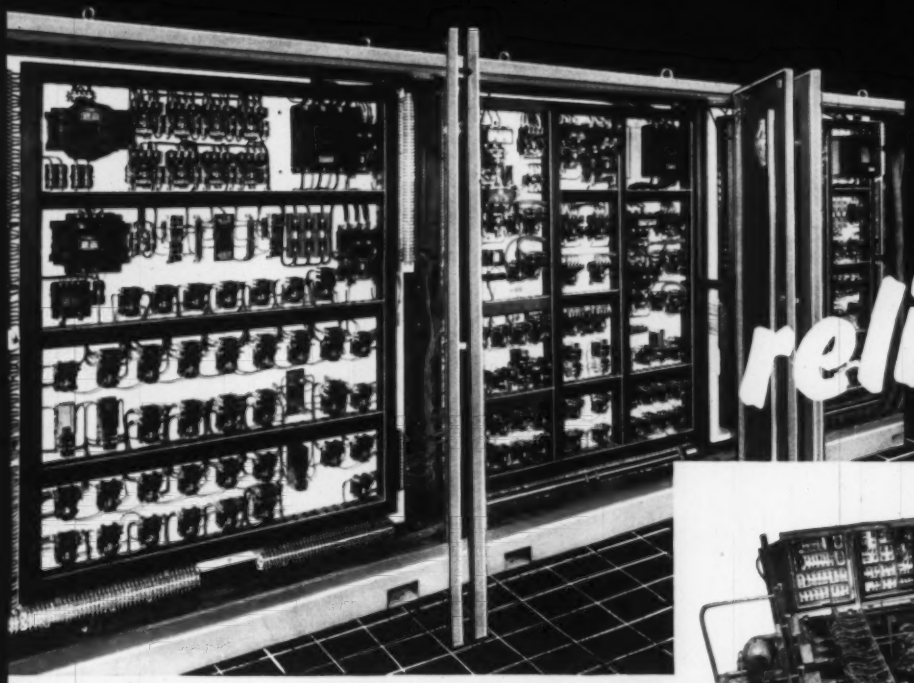
The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many advantages of Terry solid-wheel turbines. Write for complete details. Ask for a copy of bulletin S-116.

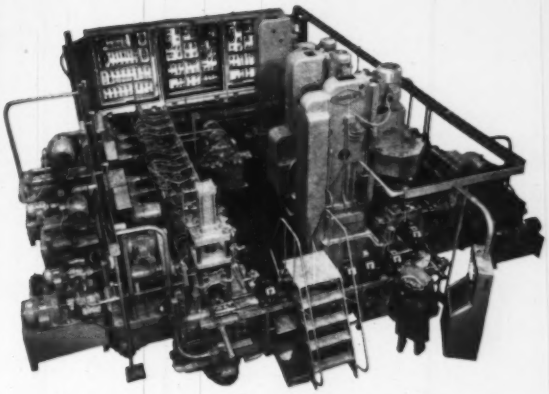
TERRY

TT-1206

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.



preferred . . . because it is reliable!



This Baker Automatic Transfer Machine is equipped with a special Allen-Bradley control panel, assembled from standard components listed in the latest A-B Handy Catalog.

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

Twenty-six machining operations are performed automatically on this huge transfer machine. To keep this machine operating continuously—to avoid costly production shutdowns—Baker Brothers, Inc., selected Allen-Bradley quality motor control—the simple control that is good for millions of trouble free operations.

The recognized reliability of Allen-Bradley motor starters and relays is the result of their simple design. Having only *one* moving part, wear and consequent trouble are reduced to the minimum. The double break, silver alloy contacts . . . standard throughout the Allen-Bradley line . . . never need attention. They are always in perfect operating condition.

Simplicity of design and silver alloy contacts are features of all Allen-Bradley control auxiliaries—they are similarly trouble free. Therefore, standardize on the Allen-Bradley line of *quality* motor starters, relays, push buttons, limit switches, and other accessories. You cannot possibly make a mistake!

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

BULLETIN 802T
Oiltight
Limit Switch

Has completely sealed operating head and switch body. This adjustable roller lever type saves installation time.

BULLETIN 700
Solenoid Relay

Universal type relay has contacts that can be connected for either "normally open" or "normally closed" operation.

BULLETIN 709
Solenoid
Starter
(Size 1)

Popular across-the-line starter with accurate and reliable overload relays. 8 Sizes to 300 hp, 220 v; 600 hp, 440-550 v.

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A-B
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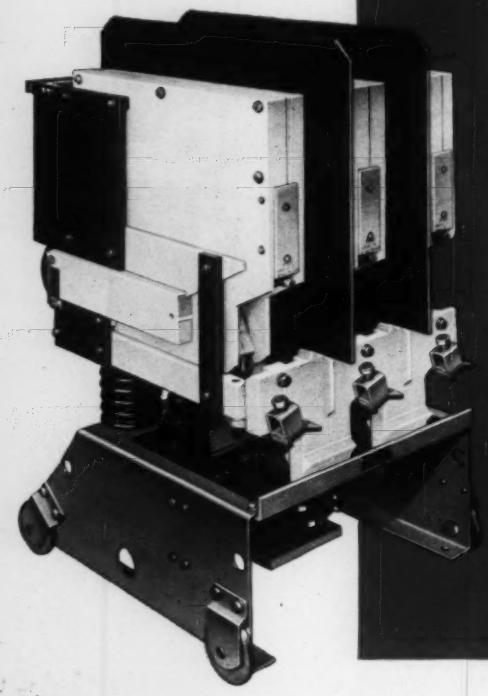
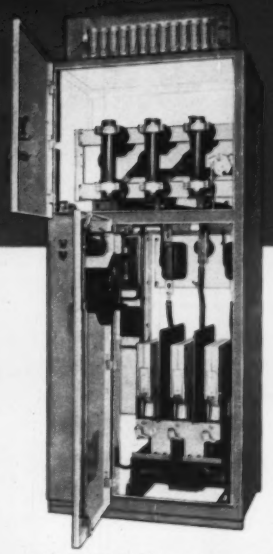


Air break starters

for high voltage motors

A-B QUALITY



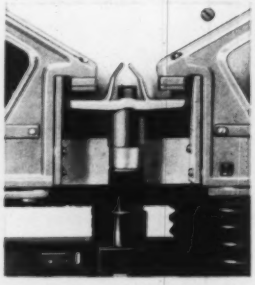
Bulletin 966 high voltage air break, across-the-line synchronous motor starter in NEMA Type 1 enclosure.

This *new* air break contactor—around which Allen-Bradley has developed a complete line of high voltage starters—is designed to match your *toughest* applications. It features the same solenoid design—with only *one* moving part—that has made Allen-Bradley low voltage starters universally recognized for their tremendous operating life.

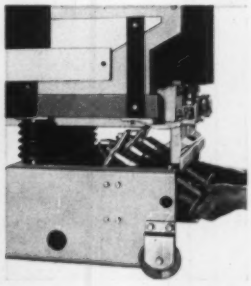
These new contactors are available in full voltage and reduced voltage starters—nonreversing or reversing—for squirrel cage, part winding, slip ring, and synchronous motors up to 1500 hp, 2300 volts; 2500 hp, 4600 volts. All starters are equipped with current limiting fuses and have an interrupting capacity of 150,000 kva at 2300 volts and 250,000 kva at 4600 volts.

It will pay you to investigate these *quality* starters. Complete information is contained in Publication 6080 . . . please send for your copy, today.

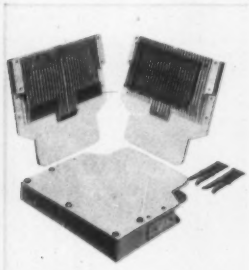
Only One Moving Part. Simple solenoid design eliminates trouble-causing pins, pivots, and flexible jumpers.



Double Break Contacts of silver alloy never need maintenance. Vertical motion assures uniform contact pressures.



Easy Access from Front. Crossbar and contacts removable from front, without special tools, for easy inspection.



Faster Arc Suppression. New blowout design and novel arc chute. Chutes are molded from an arc resistant material.

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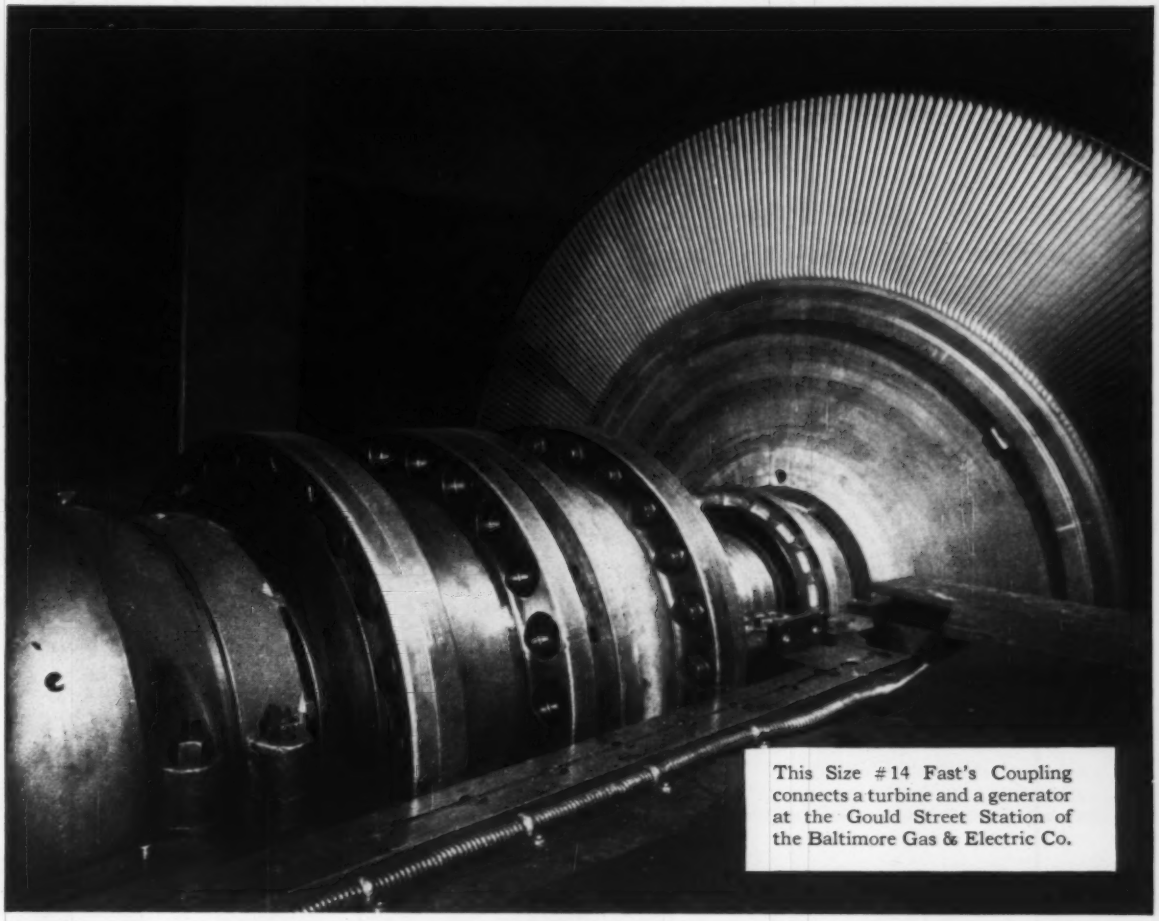
ALLEN-BRADLEY
MOTOR CONTROL
QUALITY



This Size #14 Fast's Coupling connects a turbine and a generator at the Gould Street Station of the Baltimore Gas & Electric Co.

This Fast's Coupling runs smooth after 29 years of service!

This Size #14 Fast's Coupling has never had a major part replaced since its installation on January 4, 1927.

The Baltimore Gas & Electric Company has provided excellent care and inspection . . . examining the coupling during each routine overhaul of the turbine and generator. The last inspection (shown above) was during the fall of 1955.

Unique design permits Fast's Couplings to compensate for both offset and angular misalignment of shafts and eliminates the wear of metal upon metal. It provides positive lubrication which forms a film on load-carrying surfaces of the teeth. Metal bearing rings located at the mid-axis of the teeth keep out dirt, grit and moisture—keep lubricant in. Fast's metal-to-metal seal protects the lubricant against pollution.

A Koppers engineer can show you how Fast's Couplings will give you extra years of service and reduce down-time. For more details, write to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 3404 Scott Street, Baltimore 3, Maryland.

Koppers Company, Inc.
Metal Products Division
Baltimore 3, Maryland

Engineered **Products**
Sold With ***Service***

KOPPERS

THE ORIGINAL *FAST'S Couplings*

Progress in Leadership...

SLAVE-ROBOTS WITH A SENSE OF "FEEL"

The RADIOACTIVITY levels in modern nuclear science call for the development of master-slave manipulators and slave-robots.

At Argonne, the Remote Control Engineering Division is designing a mobile robot for nuclear engineering operations beyond the capabilities of existing master-slave manipulators. The robot can be maneuvered as commanded. Its "force reflecting" servo-mechanisms will transmit the "feel" of the robot's hands to the operator. Force multiplication may be used to preserve a sense of "feel" in heavy duty manipulators. Observing the slave through stereo TV, the operator can carry out the precise remote manipulation required in nuclear work.

The development of advanced hydraulic and electrical designs of such systems is typical of the challenging problems associated with basic research and development at Argonne.

Inquiries Invited:

M.E.'s and E.E.'s for electro-mechanical, mechanisms, radio telemetering and stereo TV development work. E.E. familiar with high voltage switch gear, high voltage rectifier sets, rotating machinery, pulse transformers and techniques of high energy transient work. E.E. with cyclotron experience. Physicist for study of irradiation damage on electro-mechanical systems and optical materials. Physicist with electronic background for work in nondestructive testing.

Argonne
NATIONAL LABORATORY
Operated by the University of Chicago under contract with the United States Atomic Energy Commission

Professional Personnel Office
P. O. Box 299-A2, Lemont, Ill.

"... no one could go wrong in buying a Nordberg engine ..."

says Mr. Walter Scales
Manager
Conway Corporation
Conway, Arkansas

The Conway Light, Power and Water System is owned by the City of Conway, Arkansas, and operated by the Conway Corporation. Mr. Walter Scales, its manager, has this to say about Nordberg power:

"Our first Nordberg engine was installed late in 1951. That engine now has over 36,000 hours of running time on it. During the calendar years 1952 thru 1956 the engine was on the line 75% of the possible running time. During one period of 43 consecutive months the engine was operated over 90% of the possible running time and accounted for 75% of our total plant generation during that period.

"Our second Nordberg went into operation in 1956 and now has over 8,000 hours on it. There is every indication that it will be as satisfactory, and even more economical, than the first engine. Our opinion is that no one could go wrong in buying a Nordberg engine."

When you need *long-term, dependable* power, consult Nordberg . . . builders of a full line of engine sizes from 600 to over 12,000 hp, including Diesel, Duafuel® and Spark-Ignition Gas types.
NORDBERG MFG. CO., Milwaukee, Wisconsin

Installation Data:

City of Conway, Arkansas:

Two Nordberg 2-cycle Duafuel® engines installed, total of 6225 hp.

- First engine installed late 1951 . . . rated 2750 hp, 1940 kw.
- Second engine installed late 1955 . . . rated 3475 hp, 2470 kw.

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

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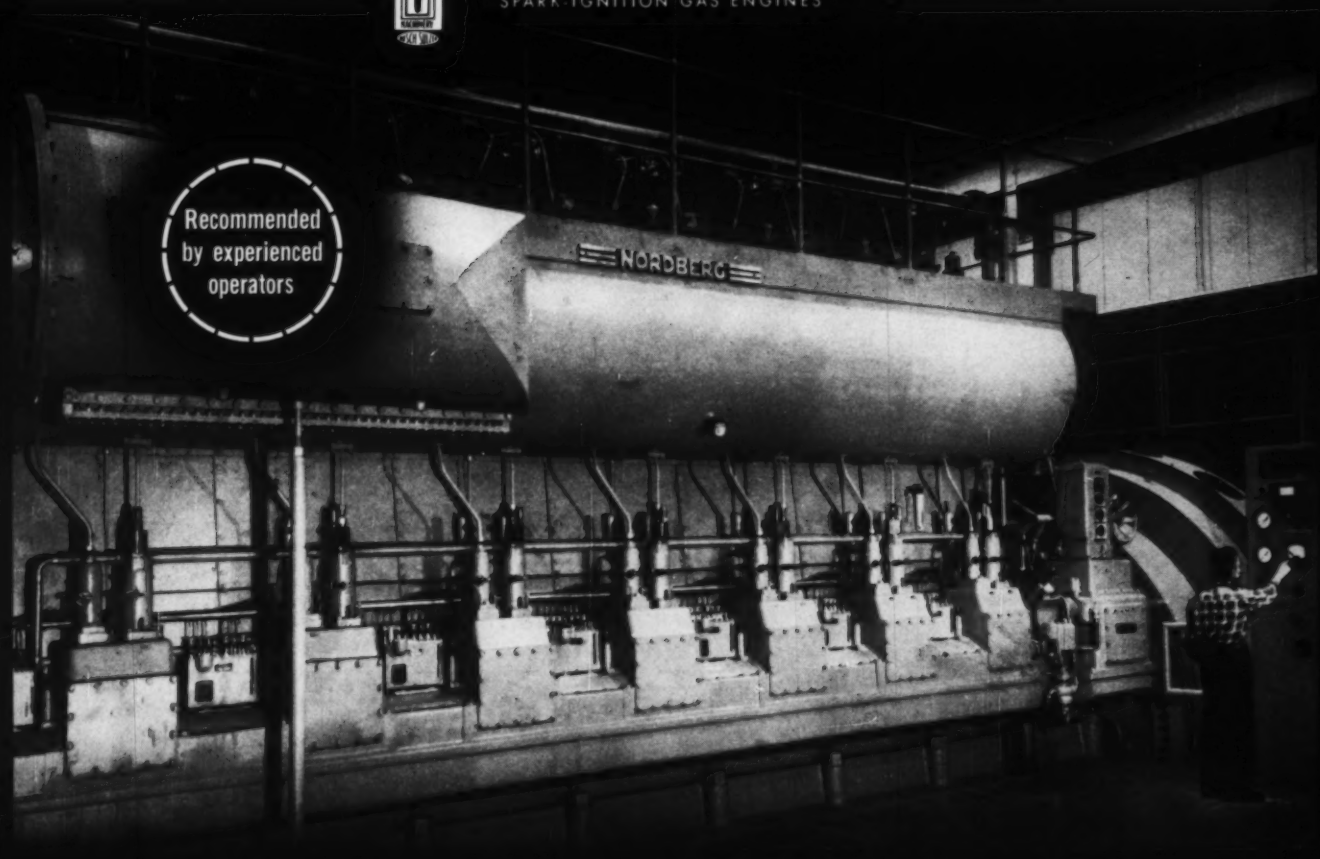
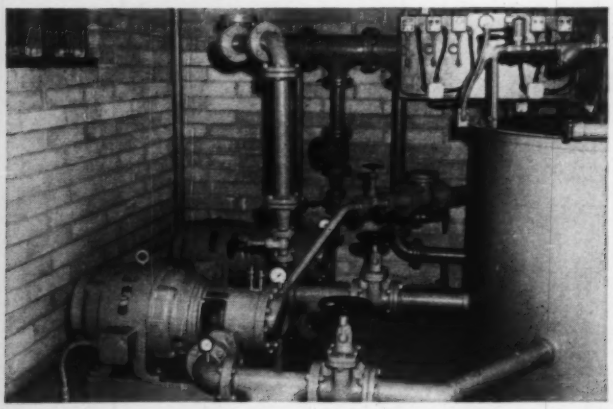


A hippo surfaces with a cavernous yawn—powered by water from F-M pumps shown below.

From butterflies to hippopotami

F-M pumps make animals "live"



In one of the world's most fabulous amusement parks, waterfalls tumble; rivers flow; hippos yawn, and giant butterflies flap their wings—all water-powered by Fairbanks-Morse pumps with F-M motors.

Although a most unusual application, these F-M installations demonstrate the flexibility and experience of Fairbanks-Morse in working with the engineers of any organization.

Whatever type, size or capacity pumps you need—you're sure of satisfaction when you call in your F-M Sales Engineer. Contact him today, or write directly to Fairbanks, Morse & Co., 600 South Michigan Avenue, Chicago 5, Illinois, Dept. ME-4.

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a name worth remembering when you want the BEST

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Is your tubing bottleneck shown here?

Bundy Engineers and versatile Bundyweld Tubing can beat the knottiest tubing design problem!

If you think it can't be done with tubing, it's a challenge to Bundy. For years, Bundy Engineers have specialized in working with customers and prospects, solving the insolvable. A unique combination of imagination and experience, plus the extreme versatility of Bundyweld Steel Tubing, has paid off again and again.

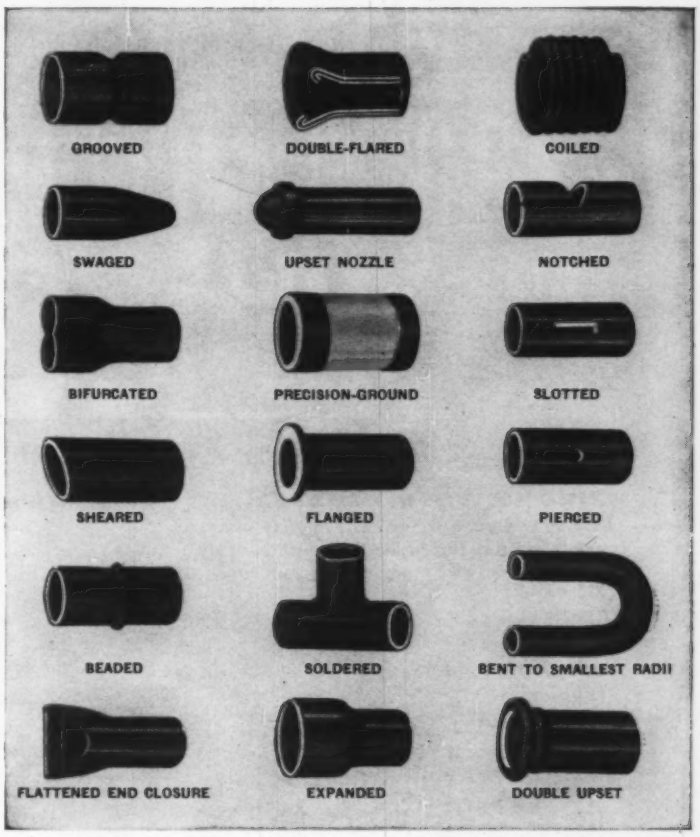
Check first with Bundy for workable solutions to your tubing design problems. Whether you are in the design, developmental, or application stage of your product, Bundy will be glad to work with you. Hundreds of manufacturers have used this Bundy service to advantage.

Bundyweld Tubing offers an unusual combination of properties: high thermal conductivity; high bursting strength; ease of fabrication; and thinner-walled, yet stronger composition. It is the safety standard of the refrigeration industry, and is used in 95% of today's cars, in an average of 20 applications each.

Call, write, or wire us today!

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN



Shown above are but a few of the fabrication operations which are possible with Bundyweld Steel Tubing. Many of these, and others not shown, were developed through solving a specific problem brought to us by a customer or prospect. Bundy invites you to avail yourself of this design service.

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through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ¾ O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

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the most efficient hydraulic circuit to handle your specific needs. We can do this while you wait.

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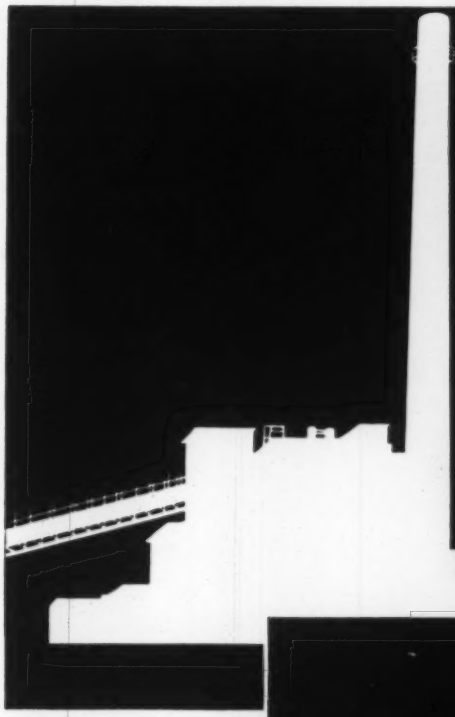
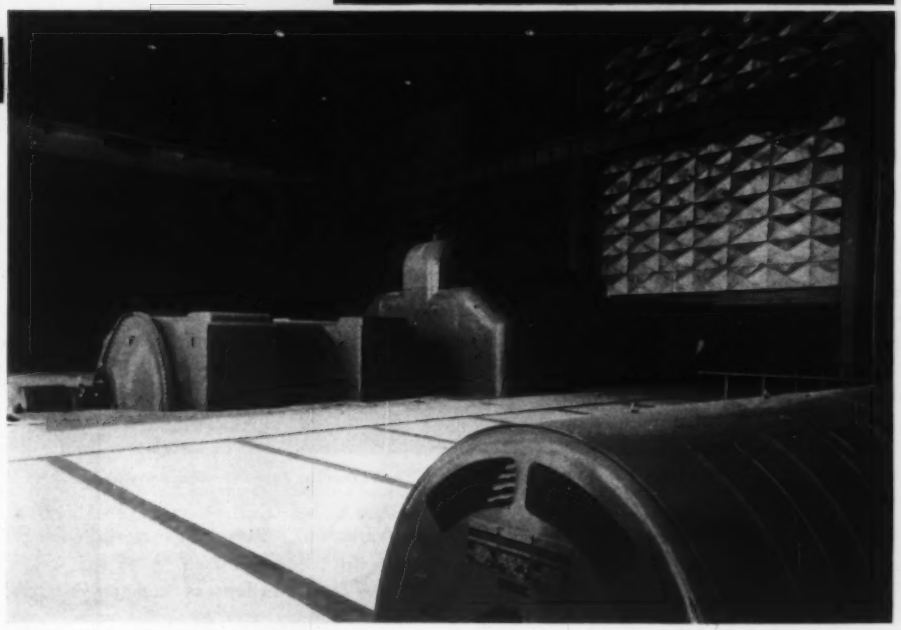
brown boveri
STEAM TURBINE GENERATOR SETS





One of two 125 MW Brown Boveri reheat turbine generator sets in a modern power plant. Many similar and larger units have been in operation for years.

AVAILABLE SIZES

(Complying with ASME-AIEE Preferred Standards)

11/12.65 MW
20/22 MW
30/33 MW
40/44 MW
60/66 MW
100/110 MW
125/137.5 MW
150/165 MW
200/220 MW

Larger units can be furnished whenever specified.

Two OF the basic reasons why Brown Boveri turbine generator sets are preferred by economy-minded utility companies . . .

1—*Guaranteed efficiency* is invariably matched (and often exceeded) in actual operation.

2—First cost represents *very substantial dollar savings.*

Write for details!

BROWN BOVERI CORPORATION

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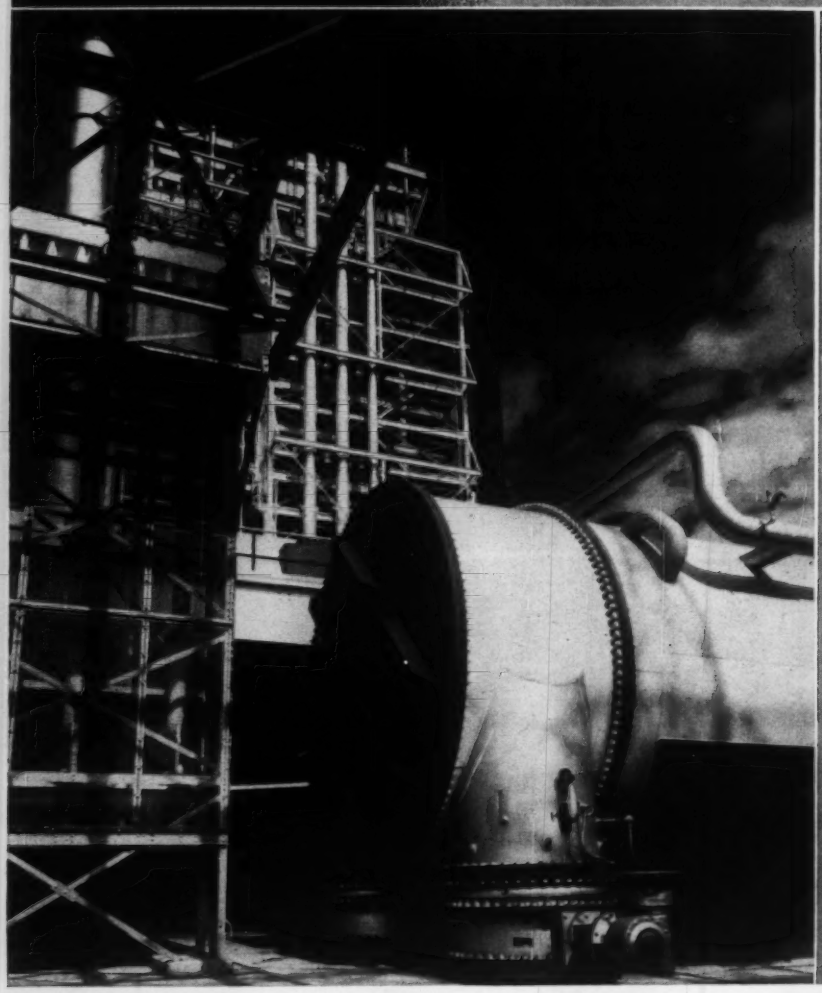
PROGRESS IN POWER through PROGRESS IN HEAT TRANSFER EQUIPMENT



LARGE CONDENSERS PRODUCED BY YUBA DESIGN ABILITY

Consulting Engineers—Ebasco Services Inc.

As the demand for larger turbines continues, Yuba keeps step with progress by furnishing surface condensers of ever increasing size and efficiency.

Here is one of two 45,000 sq. ft. condenser sections designed and built for the Collin Generating Station of the Texas Power & Light Co. The two sections connected to a single turbine exhaust by a T-piece have a total surface of 90,000 sq. ft.

Yuba has designed and built condensers with 165,000 sq. ft. of surface. The designs of these large condensers can be adapted to condensers of even greater capacity as required for larger turbines.

In the design of surface condensers, Yuba incorporates such features as low-pressure heaters and complete de-aeration facilities within the condenser shells, thereby saving costly plant space and piping.

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Engineers: Act NOW to move your career years ahead, with the company building the power plants for

ATLAS · THOR · JUPITER · REDSTONE

Even as you read this, ROCKETDYNE is testing the mighty propulsion systems to launch the major missiles of the Free World. There's a unique excitement in the work. It marks a turning point in history. Man is beginning to conquer space.

POWER—AND STILL MORE POWER

At ROCKETDYNE's 1600-acre Propulsion Field Lab. near Los Angeles, and in the new test stands at the Neosho plant in Missouri, the thrust ratings make previous engine development look puny by comparison. And still the demand is for even more power—power that gulps hundredweights of fuel per second—power that must be controlled with the delicate accuracy of a high precision instrument.

NEW WORLD OF ENGINEERING

This is a major new industry. The men who run it are professionals of an entirely new breed. Among them are mechanical and chemical engineers, physicists, dynamics specialists, creators of control systems of all kinds, heat exchange experts, research men, test engineers capable of handling the mightiest engines ever built. Every day two miles of data tape come from the test stands to teach them something new. If the state of their art could be put into print right now, the book would be out of date in a week.

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NORMAN C. REUEL received his BS in Chem. E. at Georgia Tech. and an MSAE at Cal. Tech. specializing in jet propulsion. Following rocket and radar development in the Navy he joined North American Aviation in 1946 as a research engineer. Now assistant chief of design and development, he also finds time to relax at his ranch home, bowl, golf, and play tournament bridge.

PAUL D. CASTENHOLZ, Pacific combat veteran, graduated B.Sc. (Eng.), UCLA 1949. From research engineer his grasp of rocket engine work raised him through a supervisory post in experimental development to assistant group leader in combustion devices, and then to group leader of experimental engines. Recently completed requirements for his MSc. Relaxes with hi-fi, fishing and back packing.

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Trapping Standardization

. . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

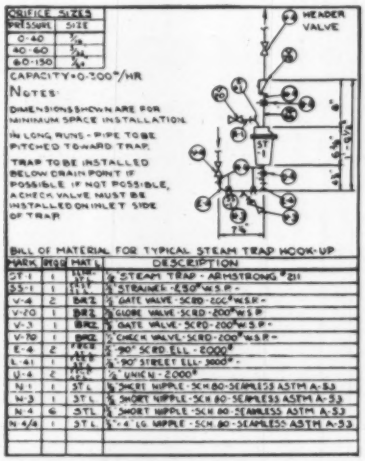
4. You can enjoy the advantages of standardized hook-ups.

Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how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DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION.
IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP.
TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE. IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP.
HEADER VALVE
BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP
MARK QTY MAT'L DESCRIPTION
ST-1 1 STEAM TRAP - ARMSTRONG #811
SS-1 1 STRAINER - 250# W.S.P. -
V-4 2 BRZ GATE VALVE - SCRD - 200# W.S.P. -
V-20 1 BRZ GLOBE VALVE - SCRD - 200# W.S.P.
V-3 1 BRZ GATE VALVE - SCRD - 200# W.S.P.
V-30 1 BRZ CHECK VALVE - SCRD - 200# W.S.P. -
E-6 2 MALL 90° SCRD ELL - 6000#
L-41 1 MALL 90° STREET ELL - 3000#
U-6 2 MALL UNION - 2000#
N-1 1 STL SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-3 1 STL SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4 6 STL SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N 4/4 1 STL 4 LG NIPPLE - SCH 80 - SEAMLESS ASTM A-53

Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.

2. Strainer ahead of trap protects it against dirt and scale.

3. Blowdown valve in strainer provides easy cleaning.

4. Check valve in discharge line isolates trap when test valve is opened.

5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8942 Maple St., Three Rivers, Michigan.**

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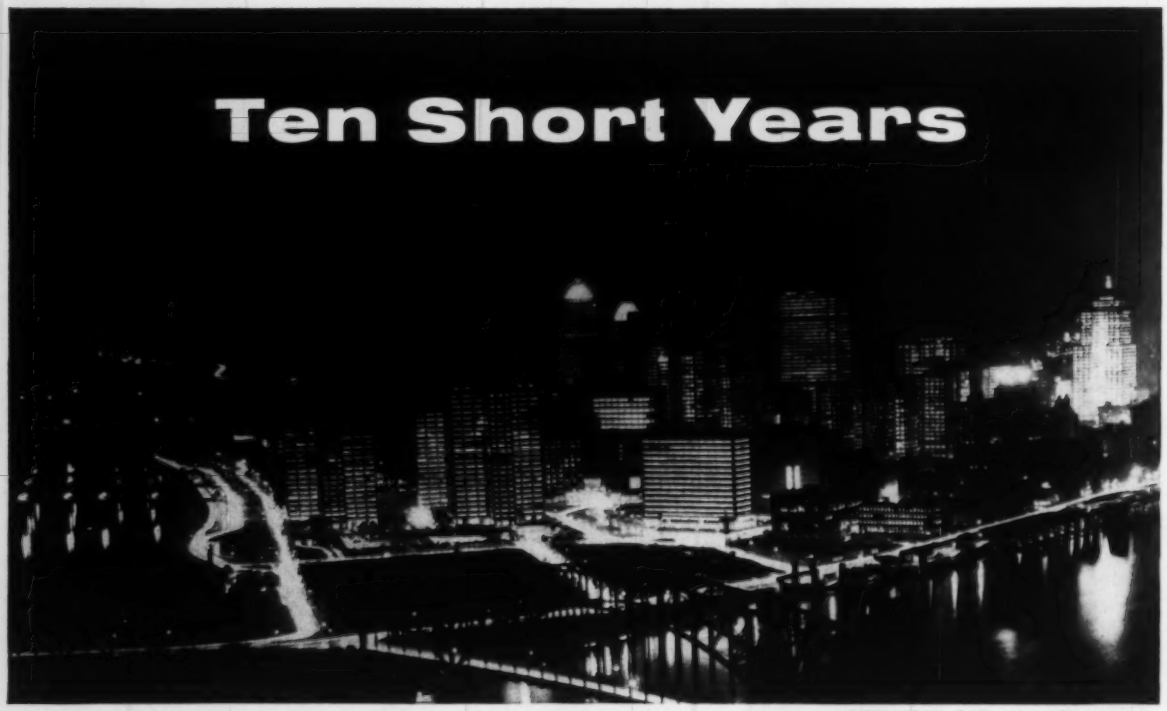

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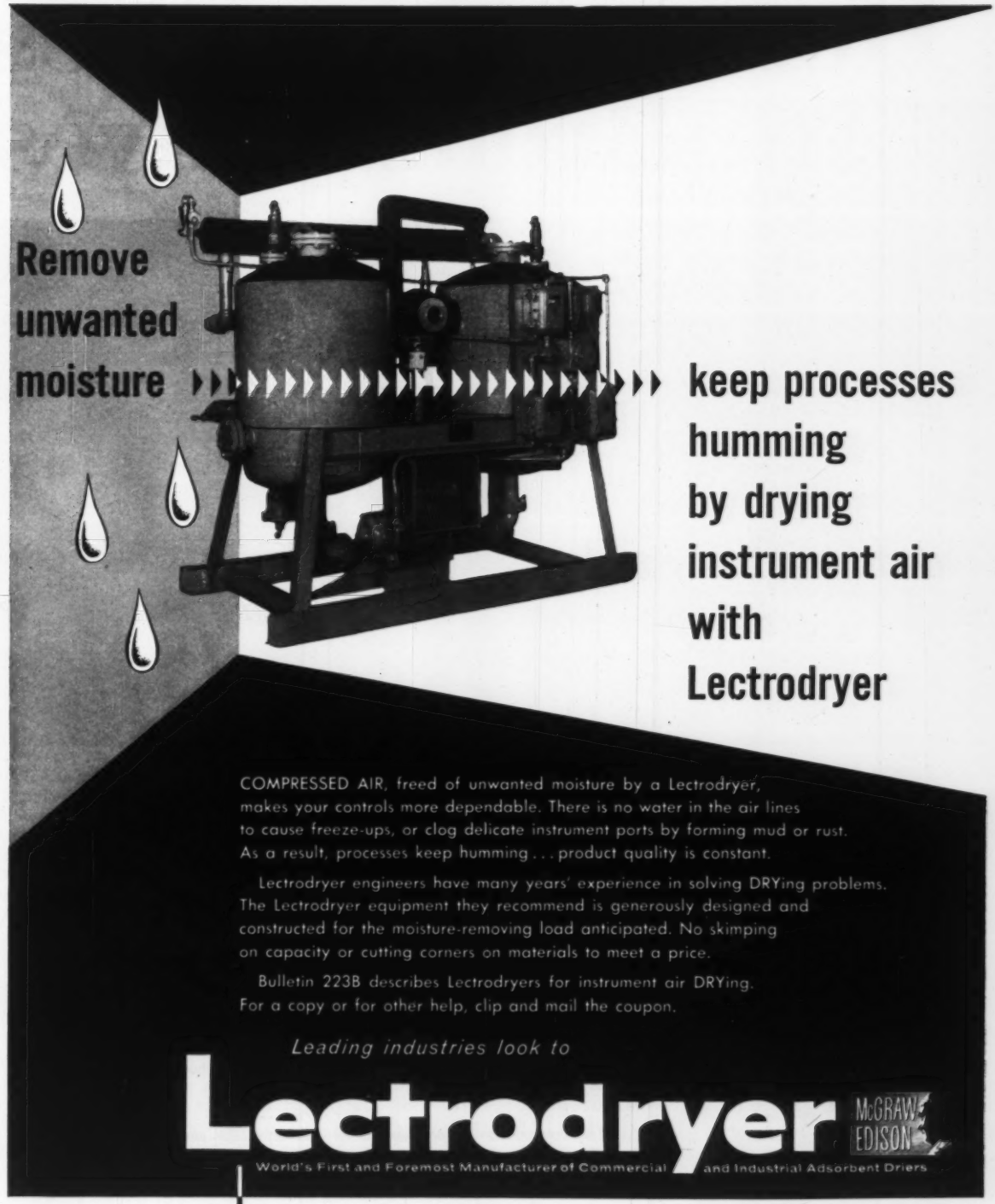

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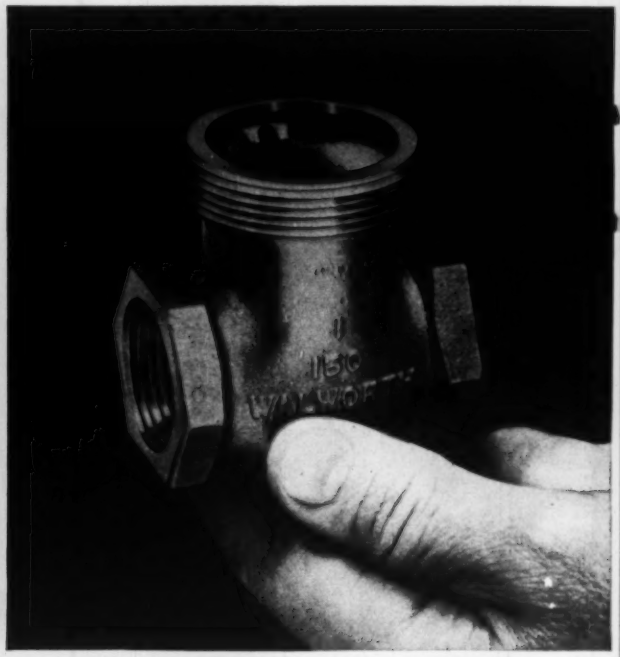

TYPICAL OF WALWORTH QUALITY is the union body-to-bonnet connection which stiffens the body against internal pressure; makes taking the valve apart a simple operation and reduces the chances of distortion or leakage even though the valve is repeatedly taken apart and reassembled. With this type of construction there is no possibility of the bonnet coming off the valve while the handwheel is being turned.

HEAVY BODY CONSTRUCTION is typical of *all* Walworth Bronze Valves. Extra-thick walls and rugged wrench hexes constitute a high safety factor and prevent distortion while the valve is being installed in the pipeline. Extra-deep pipe threads are accurately machined to eliminate leakage. Walworth Bronze Valves are also available with flanged, silver-brazed or soldered ends in certain sizes and types.

MEET THE CHAMP! The chief engineer of a midwestern plant had used a parade of valves in severe boiler blowdown service. Most didn't last longer than 60 days. None survived 90 days.

On the recommendation of a Walworth Representative the engineer installed the Walworth No. 225P Bronze Globe Valve shown here, stating that he would be entirely satisfied if it lasted a bare three months. Exactly 4 years and 362 days later the valve was taken out of service—not due to the wire drawing, steam cutting and galling which made the other valves short-lived—but because the highly turbulent steam finally wore a small hole in the body.

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TO REDUCE WIRE DRAWING to a minimum, certain types of bronze globe valves have stainless-steel plug-type seats and discs heat-treated to a nominal hardness of 500 Brinell, adding years to valve life even in severe services. These valves can be tightly closed on sand, grit or pipe scale without damage. Seats and discs are machined simultaneously, assuring perfect mating.

There is a Walworth Bronze Gate, Globe, Angle or Check Valve for every service. Walworth is continually developing new valve types and materials, including plastics, to keep pace with the growing variety and severity of services in modern industry. For full information, see your Walworth Distributor or write: *Walworth, 750 Third Ave., New York 17, N. Y.*

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DESIGN	**Control mechanisms:** Senior openings, original design – including control rods, safety rods, drives, allied tooling. Also mechanical design (light and heavy) and general machine design. **Electrical:** Originate and develop major control and power systems and components. **Process systems & equipment:** Prepare layouts and specs. – pumps, heat transfer equipment. **Process instrumentation:** Reactor, auxiliary, and control systems. **Facilities – mechanical systems:** Original design – heating, ventilating, special atmospheric controls for pressure regulation, cleaning, etc. Assist on mechanical design, special handling systems, etc. **Machine design:** Heavy mechanical. Original test equipment for nuclear experiments – lead-shielded casks, remote handling cranes, etc. Machine design experience essential. **Reactor core components:** Design moderator cans, fuel elements, critical assemblies, grid plates, core supporting structures.

Other opportunities in:
Theoretical, Experimental, Solid State Physics, High Temperature
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New programs add to years-ahead backlog

Atomics International has built and is operating two power reactors—the Sodium Reactor Experiment and the Organic Moderated Reactor Experiment. Central station power plants based on these reactor concepts are in the planning stages right now. In addition, AI has just begun an advanced power reactor study for Southwest Atomic Energy Associates, a group of 15 investor-owned utility companies.

AI is expanding overseas operations. With 5 foreign reactors already in operation or being built, AI recently signed agreements with ASEA of Sweden, which has offices in 50 countries, and DEMAG of West Germany, with whom AI formed the new company, INTERATOM, in Duisburg, West Germany.

Write today for more details about exciting career opportunities at AI.

Mr. A. D. Newton, Personnel Office, Atomics International
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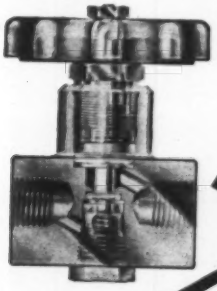

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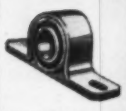

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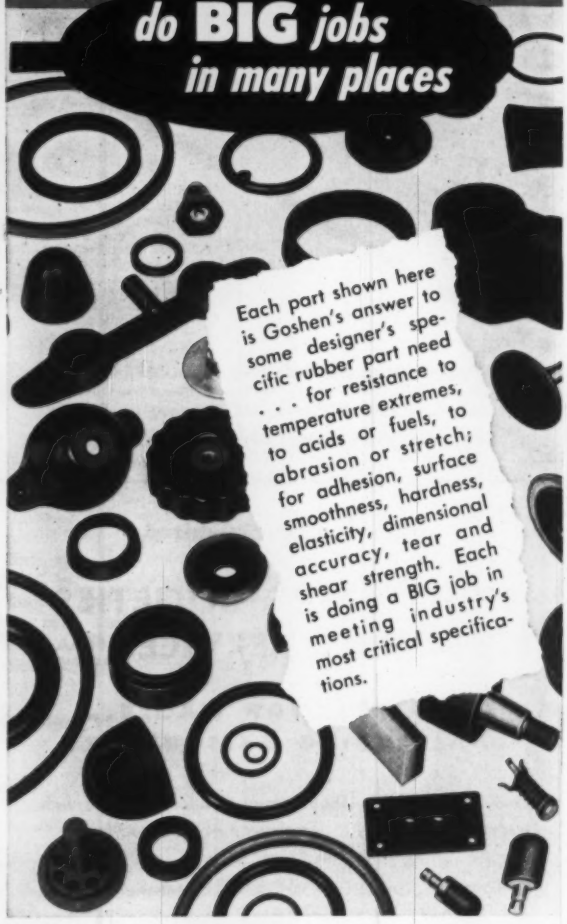

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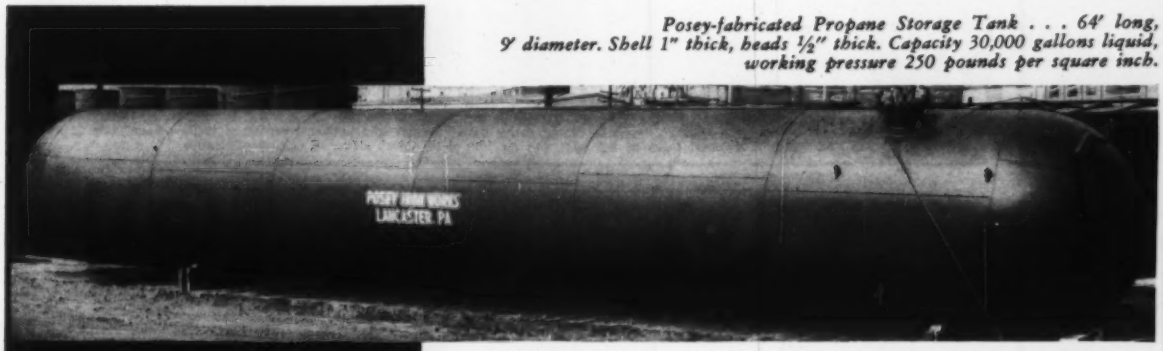

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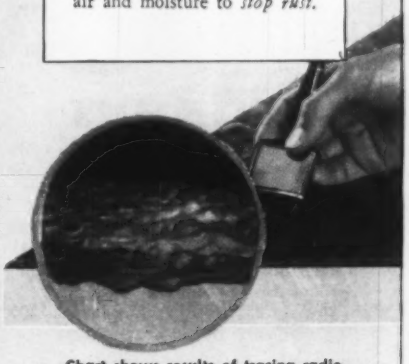

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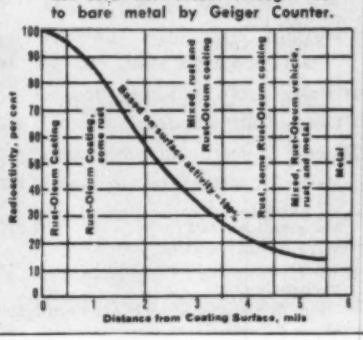

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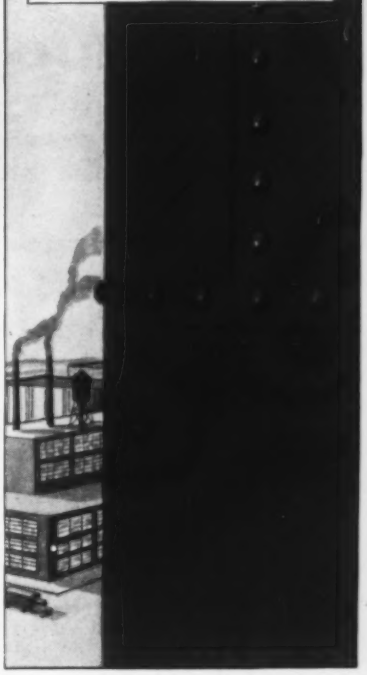

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*Aldrich Pump Co.
All American Tool & Mfg. Co.
*Aluminum Co. of America
Anker-Holth Div.,
Wellman Engineering Co.
Annin Co.
Arcos Corp.
*Associated Spring Corp.
Aurora Pump Div.,
New York Air Brake Co.

*B-L-H, Loewy-Hydropress Div.
*Babcock & Wilcox Co.
Tubular Products, Fittings Dept.
Bell Telephone Laboratories
Best, Richard, Pencil Co.
Bonney Forge & Tool Works
*Boston Gear Works
*Buffalo Pumps (Inc.)
Div. Buffalo Forge Co.
Byers, A. M., Co.

*Cash, A. W., Co.
*Chicago Bridge & Iron Co.
*Clark Brothers Co.
Dresser Industries (Inc.)
Clearprint Paper Co.
Cleveland Worm & Gear Co.
*Consolidated Chimney Co.

DeZurik Corp.
Diamond Chain Co. (Inc.)
*Diamond Power Specialty Corp.
*Dresser Industries (Inc.)
Dudek & Bock Spring Mfg. Co.
Duff-Norton Co.

*Erie City Iron Works

Faber-Castell, A. W., Pencil Co.
Faber, Eberhard, Pencil Co.
Farval Corp.
*Flexitallic Gasket Co.
Frick Co.
Funk Mfg. Co.

*Golden-Anderson Valve Specialty Co.
*Grinnell Co.

Houdaille Industries (Inc.)
Buffalo Hydraulics Div.

*Illinois Gear & Machine Co.
Imperial Tracing Cloth
Industrial Vinyls (Inc.)
*Ingersoll-Rand Co.

Keuffel & Esser Co.

*Ladish Co.
Lefax Publishers
Lenape Hydraulic Pressing & Forging Co.
*Link-Belt Co.
*Loewy-Hydropress Div., B-L-H
Lunkenheimer Co.

MB Mfg. Co.
Maryland Shipbuilding & Drydock Co.
Miehle-Dexter Supercharger Div.,
Christensen Machine Co.

Nagle Pumps (Inc.)
Niagara Blower Co.
Nice Ball Bearing Co.
*Northern Blower Co.
Nugent, Wm. W. & Co.

Oldsmobile Div.,
General Motors Corp.

*Philadelphia Gear Works
Pittsburgh Piping & Equipment Co.
Powell, William, Co.
Precision Rubber Products Corp.

Raybestos-Manhattan (Inc.)
Manhattan Rubber Div.
Packing Div.
Reliance Gauge Column Co.
*Republic Flow Meters Co.
Ric-Wil (Inc.)
Ronald Press Co.

Shenango Furnace Co.
Sly, W. W., Mfg. Co.
*Smith, S. Morgan, Co.
Spraying Systems Co.
Stephens-Adamson Mfg. Co.
Stewart-Warner Corp.
Alemite Div.
Streeter-Amet Co.
Sturtevant, P. A., Co.
*Syntron Co.

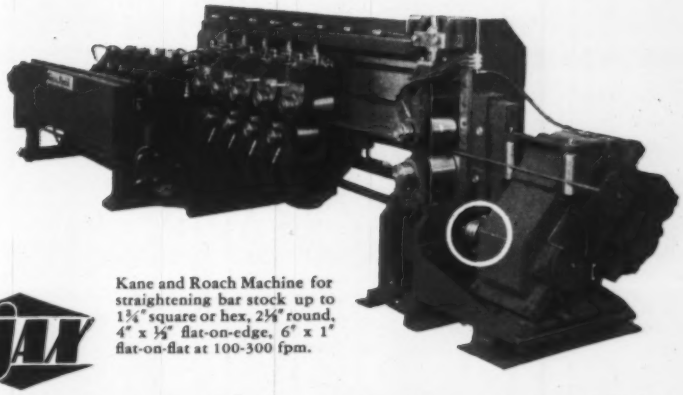
*Taylor Forge & Pipe Works
Technical Charts (Inc.)

*Union Iron Works
Universal Drafting Machine Corp.

Vickers (Inc.)
Div. Sperry Rand Corp.

Wabash Metal Products Co.
Westinghouse Electric Corp.
Sturtevant Div.
*Wheeler, C. H., Mfg. Co.
Wiegand, Edwin L., Co.
Williams Gauge Co.
Wollensak Optical Co.
Worcester Valve Co.

*Zallea Brothers
Zonolite Co.
Z-Crete Div.



Kane and Roach Machine for straightening bar stock up to 1¾" square or hex, 2½" round, 4" x ½" flat-on-edge, 6" x 1" flat-on-flat at 100-300 fpm.

AJAX

DIHEDRAL COUPLINGS

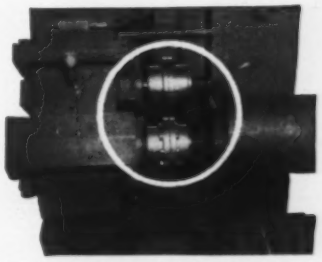
PERMIT VARYING ANGULARITY IN THE DRIVE MEMBERS OF *STRAIGHTENING MACHINES

K&R

▶ This Kane & Roach machine straightens cold or hot rolled steel and non-ferrous bar stock and AJAX DIHEDRAL COUPLINGS "straighten" angularity in the drive members.

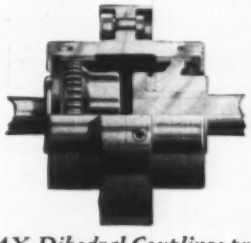
The ability of AJAX Dihedral Couplings to handle up to 12° misalignment make it possible to adjust the Horizontal and Vertical straightening units to align passes of Multipass rolls, thereby reducing roll change-over time. Production speed ranges from 100 to 300 feet per minute when straightening 65,000 pound yield material in both horizontal and vertical planes.

AJAX Dihedral Couplings are used in the primary drive and in the drive to the Vertical unit to obtain "floating shaft" action and reduce wear on the bearings of driving and driven components. An AJAX Dihedral Coupling is also used in drive to the line shaft of the Horizontal unit to assure minimum bearing wear. Adoption of AJAX Dihedral Couplings by Kane & Roach is another example of how manufacturers of quality machines are safe-guarding performance and reducing maintenance cost. AJAX Engineers will welcome an opportunity to discuss the design possibilities resulting from AJAX Dihedral Coupling Performance.



AJAX Dihedral Coupling obtains floating shaft action to permit varying of alignment of roll passes.

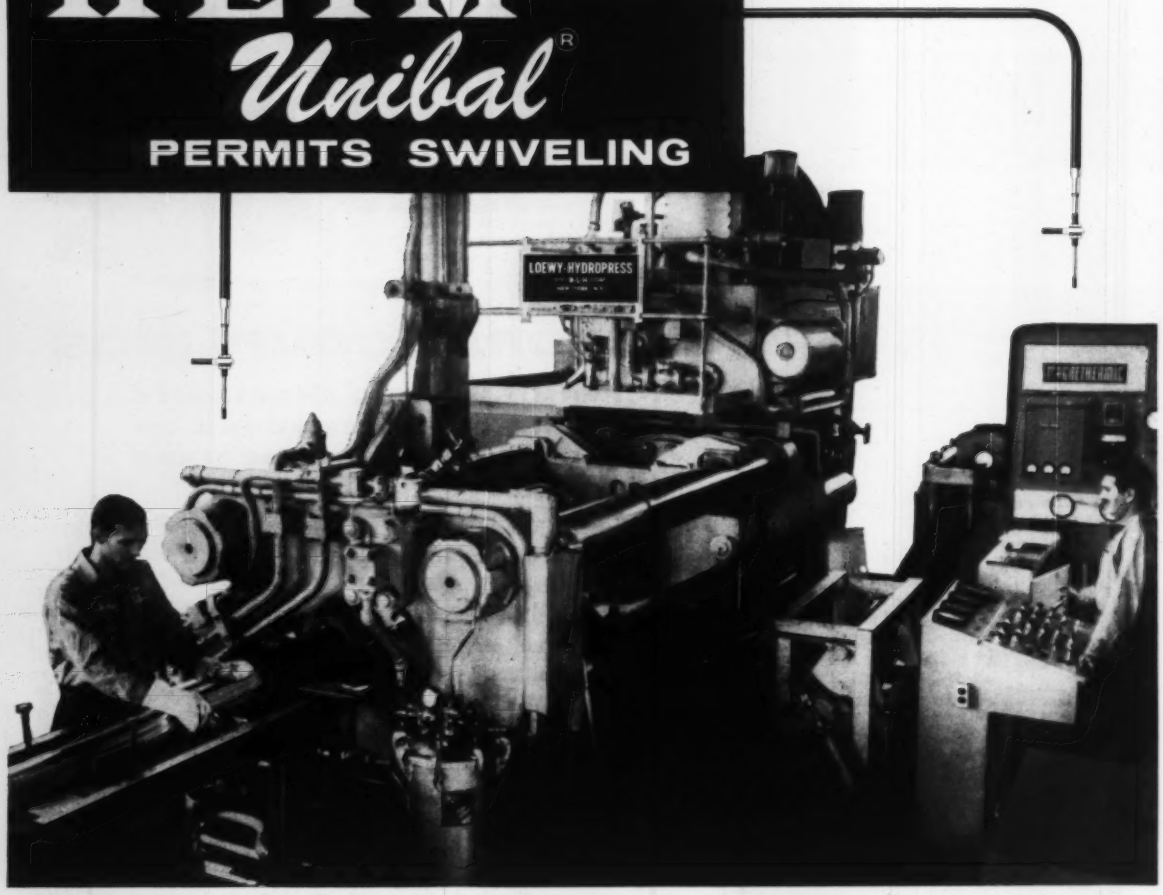
*KANE & ROACH, INC.



AJAX Dihedral Couplings protect bearings from wear due to adjustment of vertical and horizontal unit.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, NEW YORK

HEIM *Unibal*®
PERMITS SWIVELING



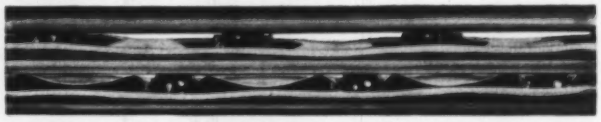
From the pulpit directly to this 1250-ton extrusion press is an ingenious, mechanical, remote push-pull control to which this giant responds. It consists of a solid, flexible stainless steel blade, 24 feet long, moving between rows of stainless steel balls and housed in a flexible tubing. It is called Controlex and is made by Controlex Corp., White Plains, N.Y.

A manually operated lever at the control board, or pulpit, moves the blade in the desired direction, and in order to permit swiveling and for the relief of eccentric thrust on the push-pull end rod, a

HEIM *Unibal*® SPHERICAL BEARING ROD END

is used at the mounting point.

Another Unibal Rod End bearing, mounted at the machine end of the control, completes the swiveling or misaligning action as required.



Controlex makes controls over 100 feet long
— a linear ball bearing with 42 balls to the foot.
Press for extruding aluminum strip, built by
Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp.

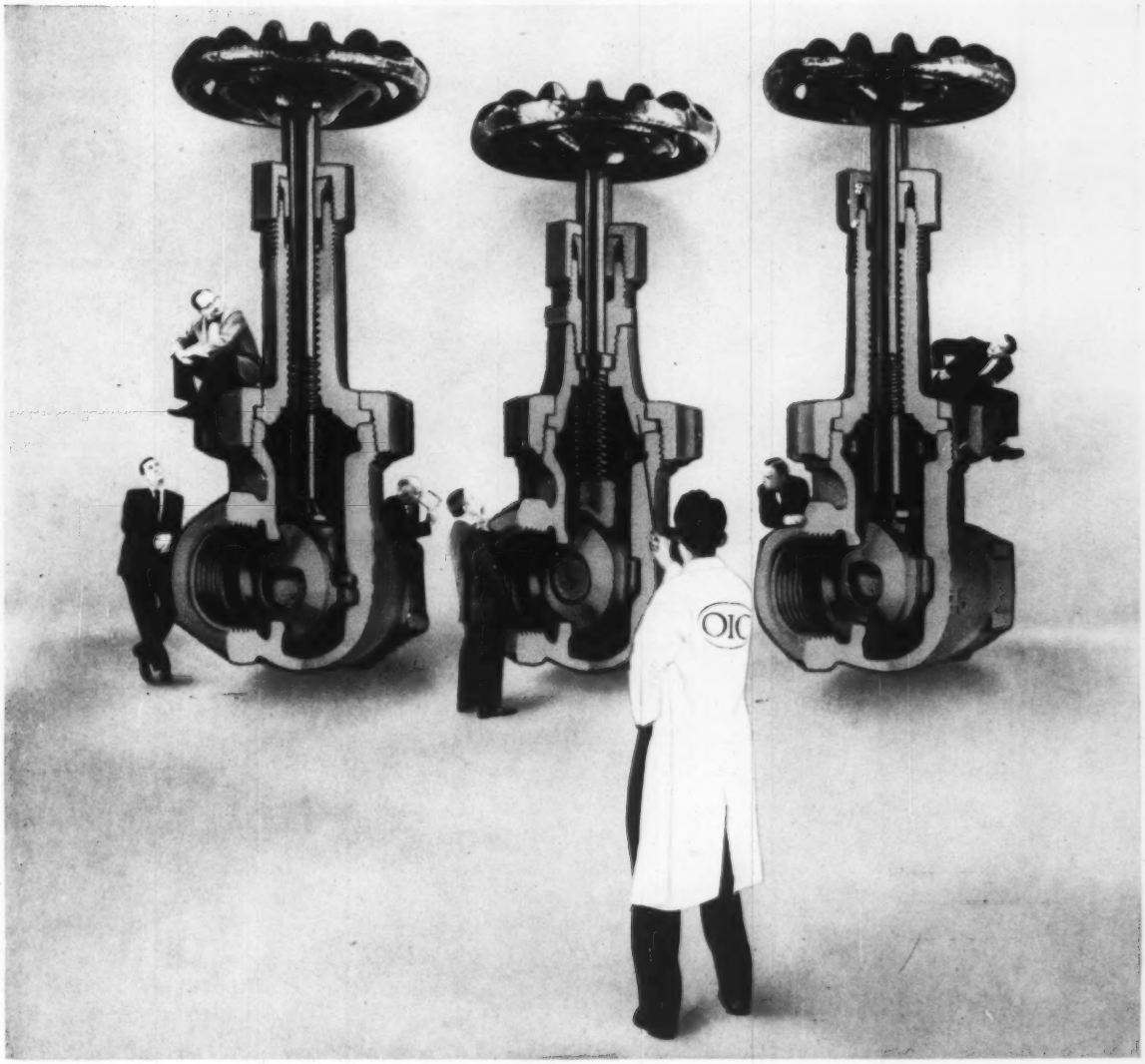
This application of the Heim Unibal demonstrates one way in which it serves as a mounting device through which the Controlex end fitting passes. Does it give you any ideas for use on *your* equipment? There seems to be an unending list of possible applications for the Heim Unibal, and our engineering department is ready to help you work out details.

Send for complete Heim bearing catalog

Sold through the leading bearing distributors.

THE HEIM COMPANY FAIRFIELD, CONN.

...3 gate valve types in 3 pressure classes, gentlemen, all with safe, efficient (and effective) union ring joints

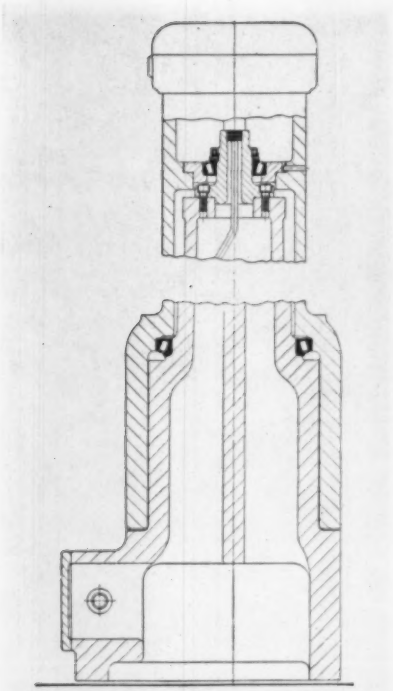


125 lb.—150 lb.—200 lb. OIC bronze gates . . . the most *modern*, complete line you'll find anywhere. Solid wedge—split wedge—rising or non-rising stems. All, of course, featuring OIC *alloy-40* stems which OUTLAST ORDINARY VALVE STEMS 10 to 1!

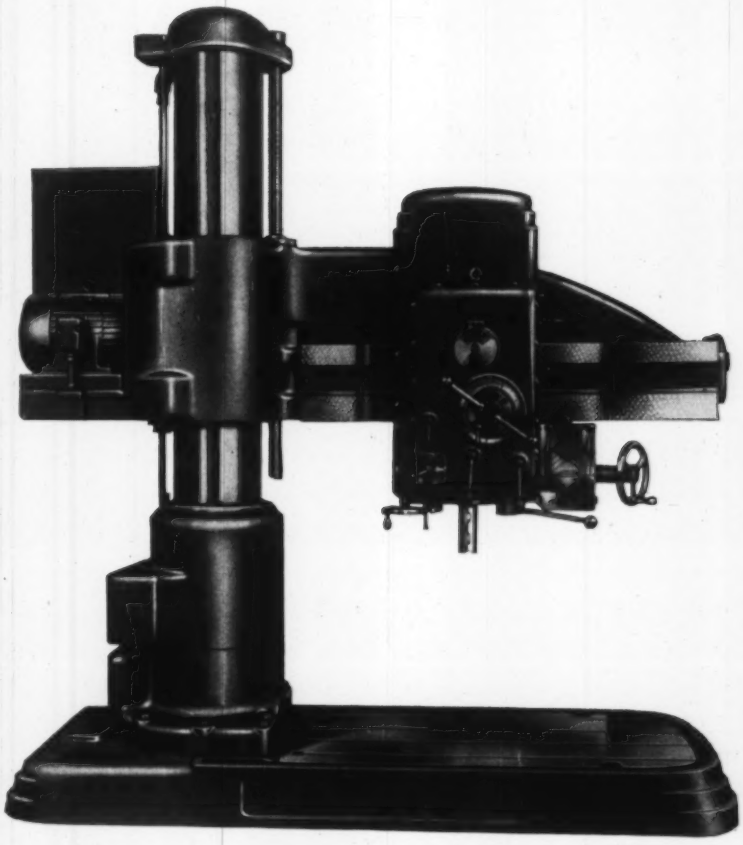
Call your OIC Distributor for quick service. Or write for specification literature.

THE OHIO INJECTOR COMPANY • **Wadsworth, Ohio**

OIC **VALVES** | BRONZE, IRON, FORGED AND CAST STEEL LUBRICATED PLUG VALVES



How **THE AMERICAN TOOL WORKS CO.** mounts column of 32-speed Hole Wizard Radial on 2 Timken bearings to increase rigidity 50%. Spindle and transmission use 11 more Timken bearings.



This radial drill has 50% more rigidity with column mounted on Timken® bearings

TO resist stresses and cut arm deflection in half, the column unit of this 32-speed Hole Wizard Radial is mounted on two Timken® tapered roller bearings. With a large, preloaded Timken bearing at top and bottom, The American Tool Works Company gives the column and sleeve the rigidity of a single piece. This results in greater accuracy and longer cutting tool life, permits higher speeds and coarser feeds.

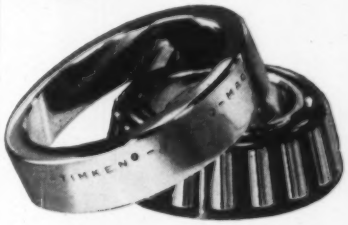
HOW COLUMN IS HELD RIGID. Timken bearings keep the column unit in positive alignment. Their tapered design lets them take both thrust and radial loads in any combination. And full line contact between rollers and races gives Timken bearings load-carrying capacity to spare.

HEAVY SHOCKS ABSORBED. Rollers and races of Timken bearings are case-carburized to give them hard, wear-resistant surfaces over tough, shock-resistant cores. They reduce maintenance.

FRICTION VIRTUALLY ELIMINATED. Timken bearings run smoother, last longer, because they're geometrically designed for true rolling motion—and precision-made to live up to their design. We even make our own electric furnace, fine alloy steel—the only American bearing maker who does.

So whether you buy or build machines, it pays to specify bearings trademarked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

TRADE-MARK REG. U. S. PAT. OFF.